Arrow Vision Series

WEBENCH® Power Designer

Power Supply Design In Seconds!

Objectives

- WEBENCH® Overview
- Efficiency Calculation and Design Optimization
- Electrical and Thermal Simulation
- Build it and Reporting

13 Years of Modeling and Verification

Faster & More Effective

Offline Past

Trial and Error

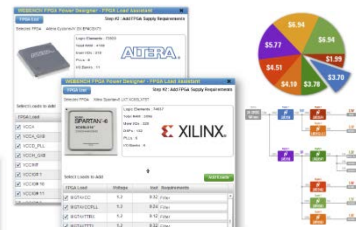
1999 Online

WEBENCH® Design Tools

2009 Visualizer

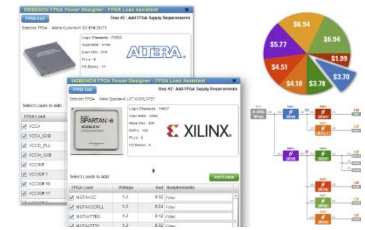
Agile Designs

2010 FPGA Power Architect



Agile Systems

2012 FPGA System Power Architect



Complete Systems

New Capabilities

WEBENCH® Tools

Power Designer	Power supply and system power architecture
LED Designer	LED driver design and LED architecture
Sensor Designer	Sensor analog front end design
Active Filter Designer	Filter design and simulation
PLL Designer	PLL implementation
Amplifier Designer	Op amp design and simulation

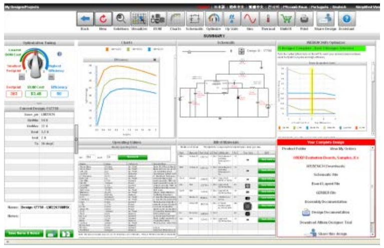
Beginning to end: Design and Prototyping

1. Choose a Part

Enter Specifications

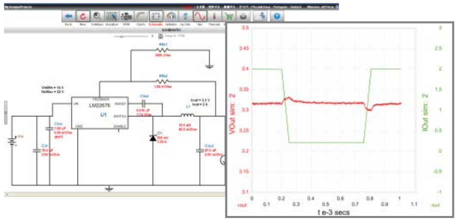
Select Part

2. Create a Design

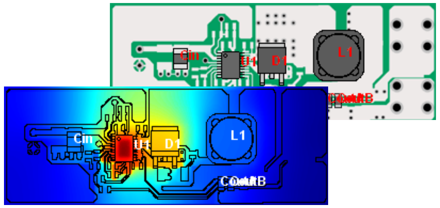


Optimize for Footprint and Efficiency, Use Graphs to Visualize Design

3. Analyze a Design



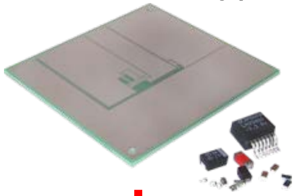
Generate Schematic/ Electrical Analysis



Generate Layout/ Thermal Analysis

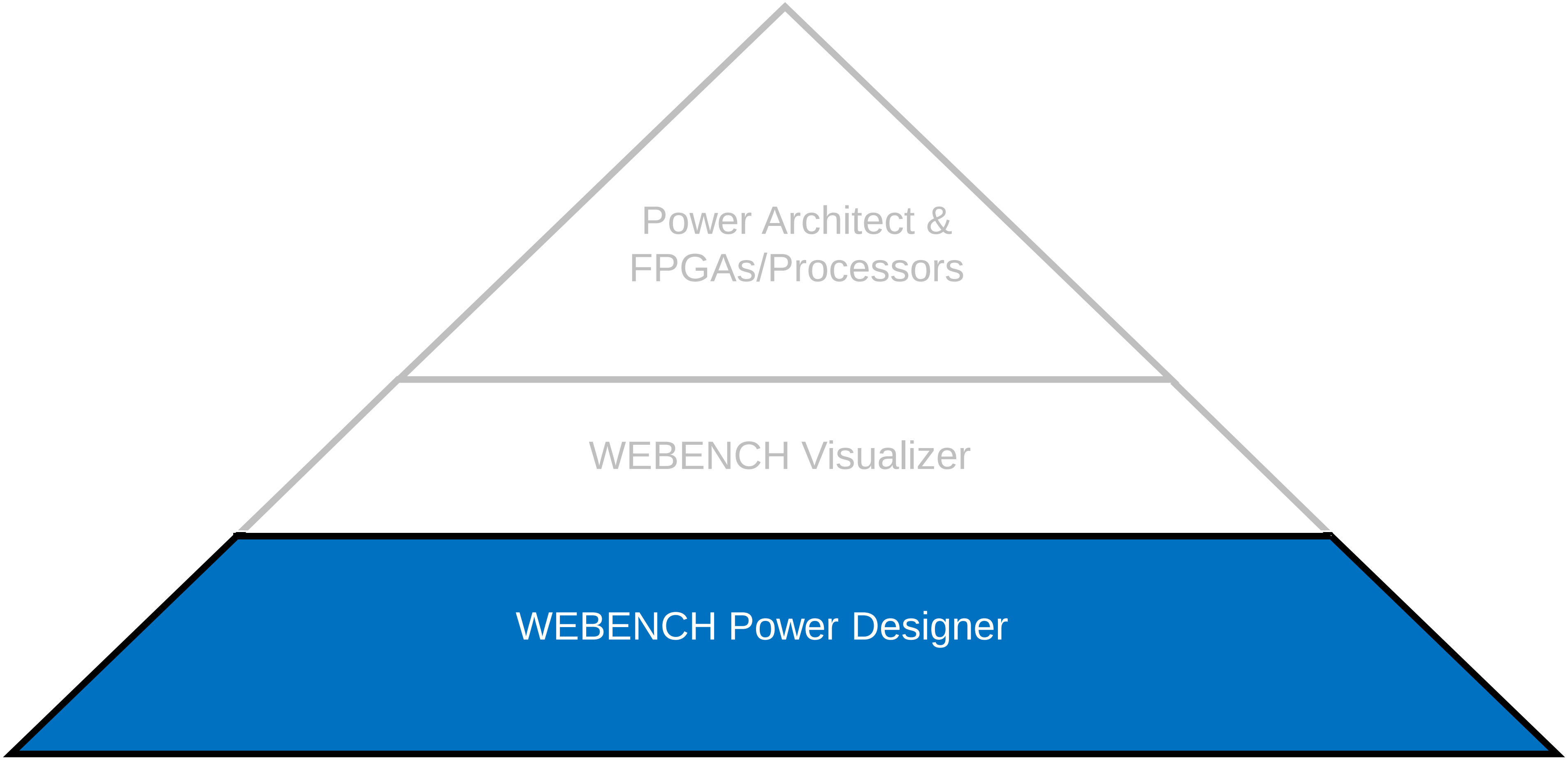
4. Build It!

Schematic Export
Custom Prototype Kit



Prototype

The WEBENCH® Power Tool Suite



WEBENCH® Supports Broad Portfolio
13 Years of Modeling and Verification

Circuit Calc & Sim model

- LM10500
- LM2012x/3x/4x/54
- LM20242
- LM20323/33/43
- LM21212/5
- LM21305
- LM(2)5005/07/10/11
- LM(2)5085/88
- LM(2)5085/88
- LM(2)5116
- LM(2)5117
- LM26001/3
- LM2696
- LM2734/35/36
- LM27341/2
- LM27341/2
- LM2734/5/6
- LM27402
- LM2743
- LM2830/31/32
- LM2841/42
- LM2852/53/54

- LM3100/02/03
- LM3478/88/81
- LM34910/17/19/23/30
- LM3670/71/73/74
- LM5001/02/6/8/9
- LM5022
- LMR10510/15/20
- LMR12010
- LMR14203/6
- LMR24210/20
- LMR62421
- LMZ22008/10
- TPS2420
- TPS92550/1

Circuit Calc but no Sim model

- LM(2)5118/9
- LM2622
- LM3224
- LM2700
- LM2698
- LM2731
- LM3668
- LMR62010/4
- TPS40170
- TPS40210
- TPS40303/4/5
- TPS51225
- TPS51315
- TPS53313/6
- TPS5401
- TPS54040
- TPS54060/61/62
- TPS5410/20/30/50
- TPS54140/60
- TPS54218

- TPS54231/2/3
- TPS54240/60
- TPS54310-8
- TPS54320/5/6
- TPS54331/2
- TPS54418
- TPS54478
- TPS54610-8
- TPS61170/5
- TPS62080/1/2
- TPS62125
- TPS62130/1/2/3
- TPS62140/1/2/3
- TPS62150/1/2/3
- TPS62200-8
- TPS62240/2/3
- TPS622601/2/3
- TPS62290/1/3
- TPS842/4/610

WebTHERM /Build It

- LM22671-9, LM22680
- LM(2)5574/5/6
- LM2585/6/7/8
- LM2595/6/8/9
- LM2670-9
- LM3150/1/2/3
- LM3402/4(HV)
- LMZ10503/4/5
- LMZ12001/2/3/8/10
- LMZ13608/10
- LMZ14201/2/3
- LMZ22003/5/8/10
- LMZ23603/5

Switchers/Controllers/LED Drivers:
378 base part numbers
LDOS: 50 base part numbers

Supported Topologies: Buck (over 60% of total designs), Boost, Flyback, SEPIC, Inverting Buck/Boost, LDO, HotSwap, Modules

Coverage of WEBENCH® enabled parts (Buck Switchers)

Iout

- 40A-60A: LM(2)5119, LMZ3610, LMZ22010/8 (interleaved)
- 30A: LM27402, TPS40210,
- 25A: TPS40303/4/5, TPS40170

Vout Min

- 0.5V: TPS62080/A
- 0.6V: LM283x, LM2743, LM3150, LMZ10500/1, LM21305, LM27402, LM21212/5, TPS54478, TPS53313/6, TPS6224060/90, TPS54622/3

Vin Max

- 100V: LM5116/79
- 95V: LM5008/9
- 75V: LM5005/6/7/10, LM5574/5/6, LM5085/88

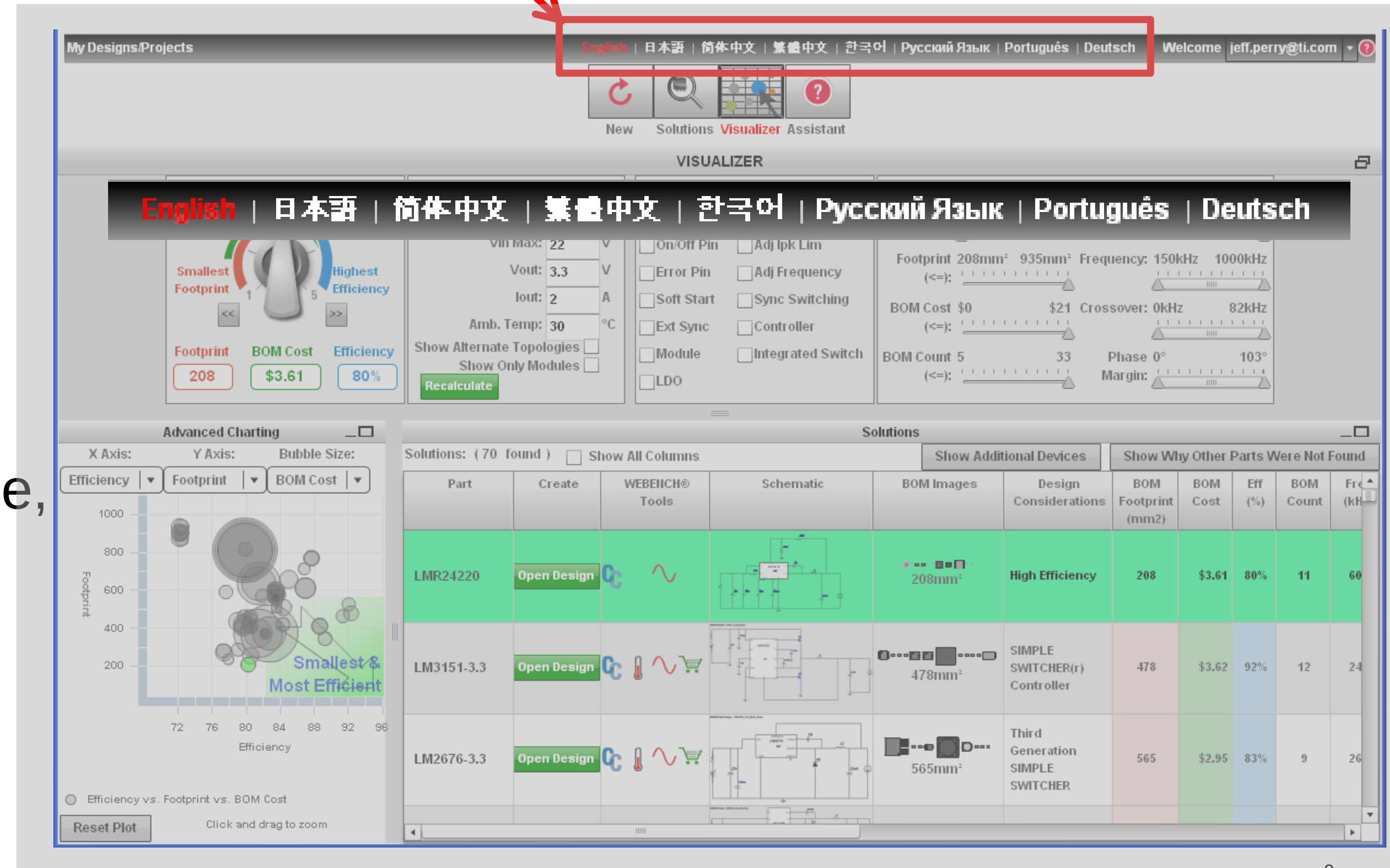
Vin Min

- 1.0V: LM2743
- 2.0V: TPS62243/42/61/62
- 2.3V: TPS62080/81/82, TPS62240/93

Multilingual Capability

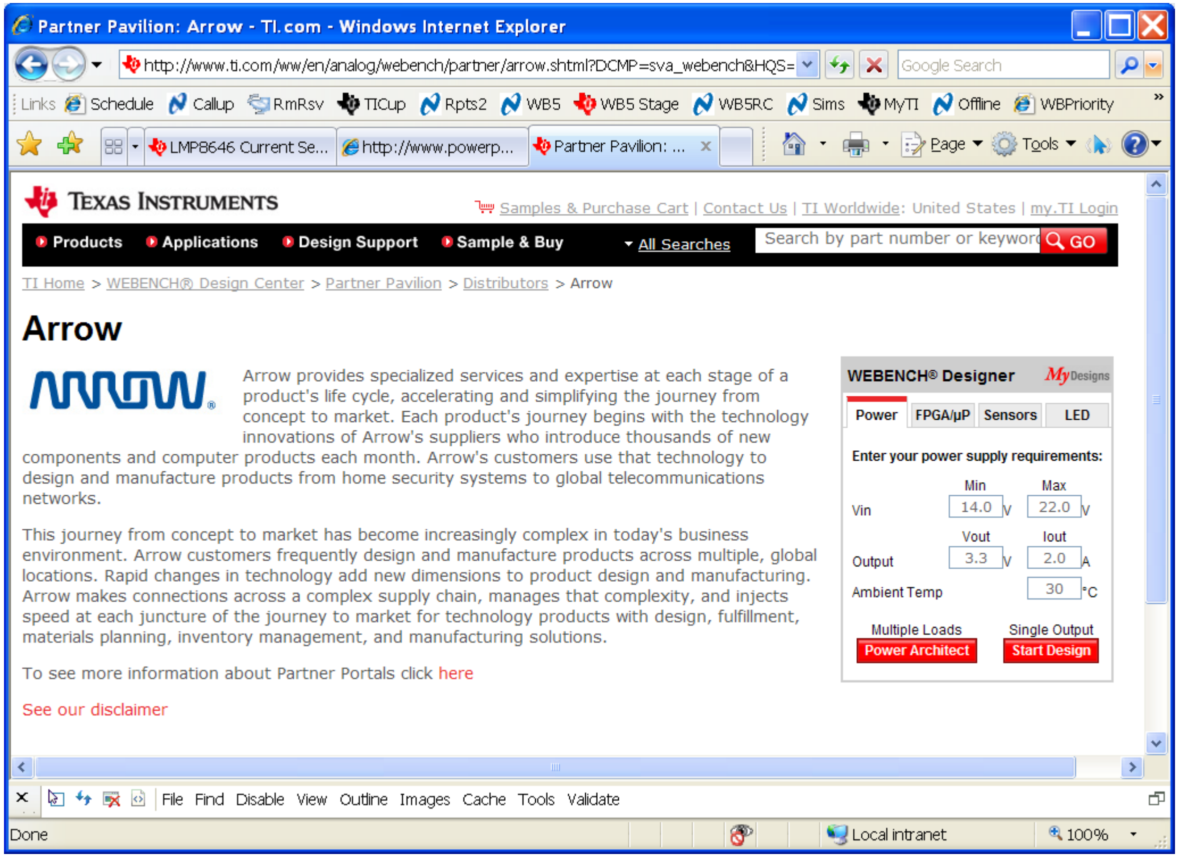
Select from the language bar

Japanese,
Chinese,
Korean,
Russian,
Portuguese,
German

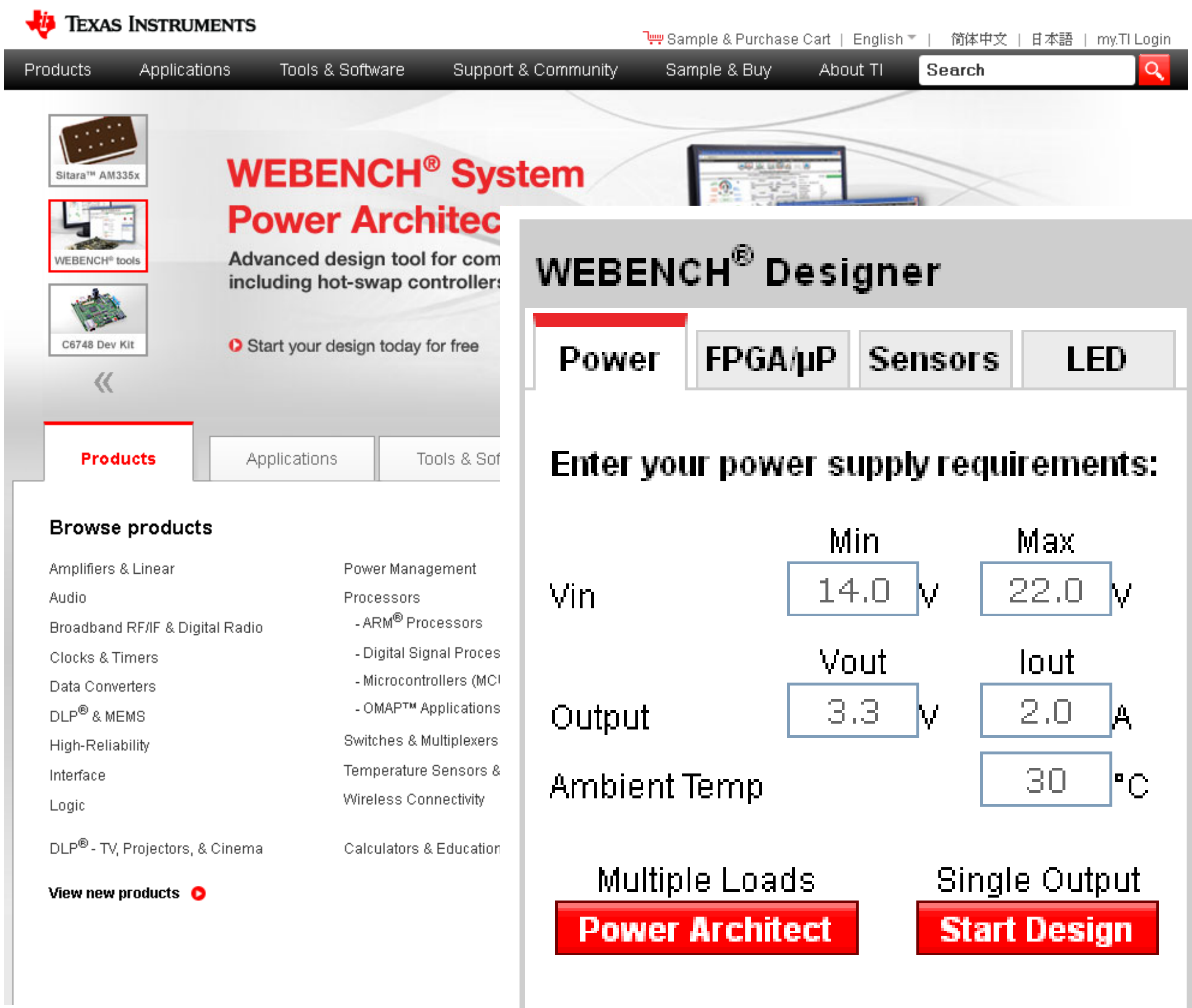


Arrow WEBENCH Designer

- Access customized versions of WEBENCH® Designer:
- http://ti.com/arrow



Ways to Access WEBENCH® Designer

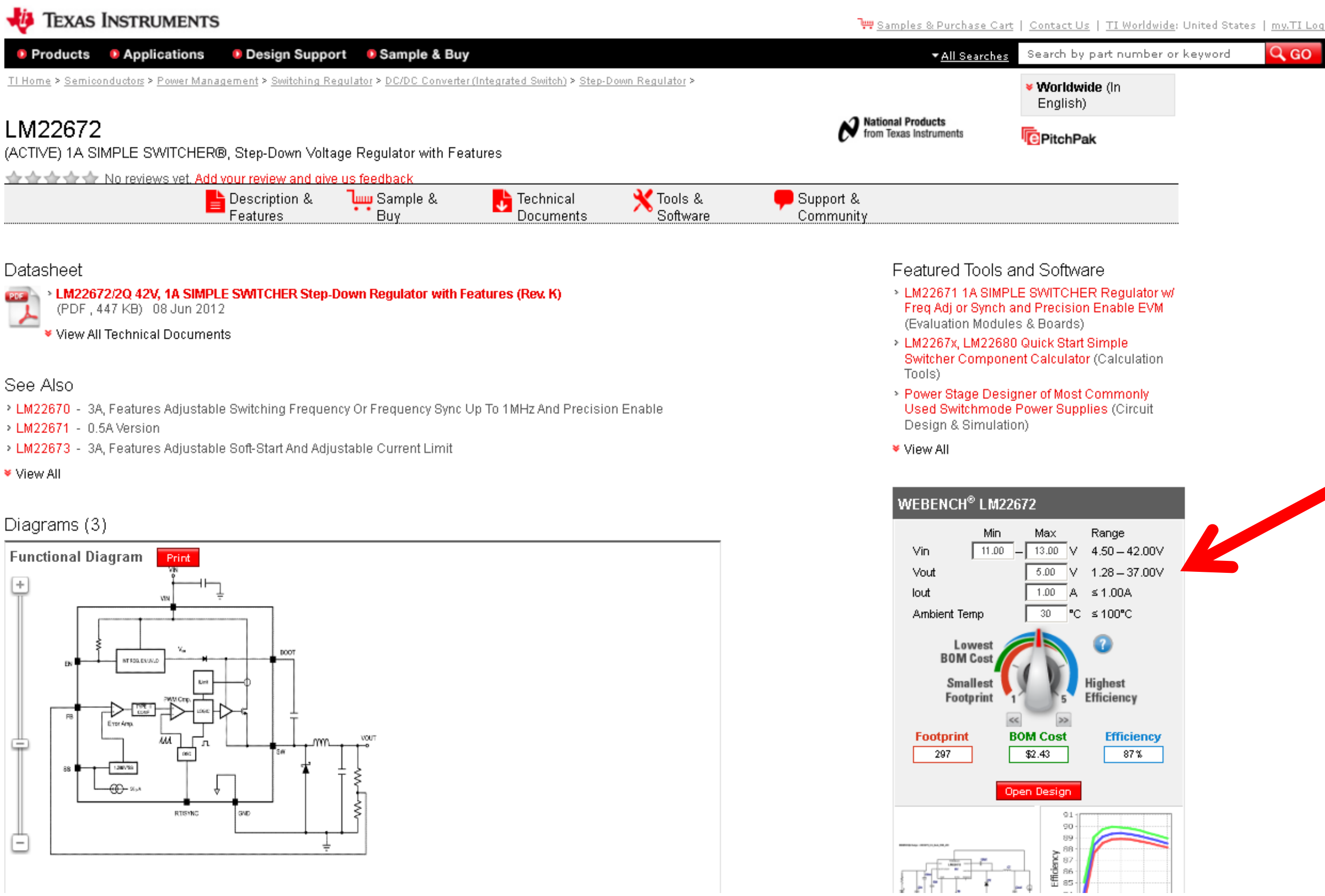


- Use the entry panel on:

  http://www.ti.com

- Select the specific tool
  - Power
    - Power Architect
    - Start Design
  - FPGA/µP
  - Sensors
  - LED

Ways to Access WEBENCH® Designer



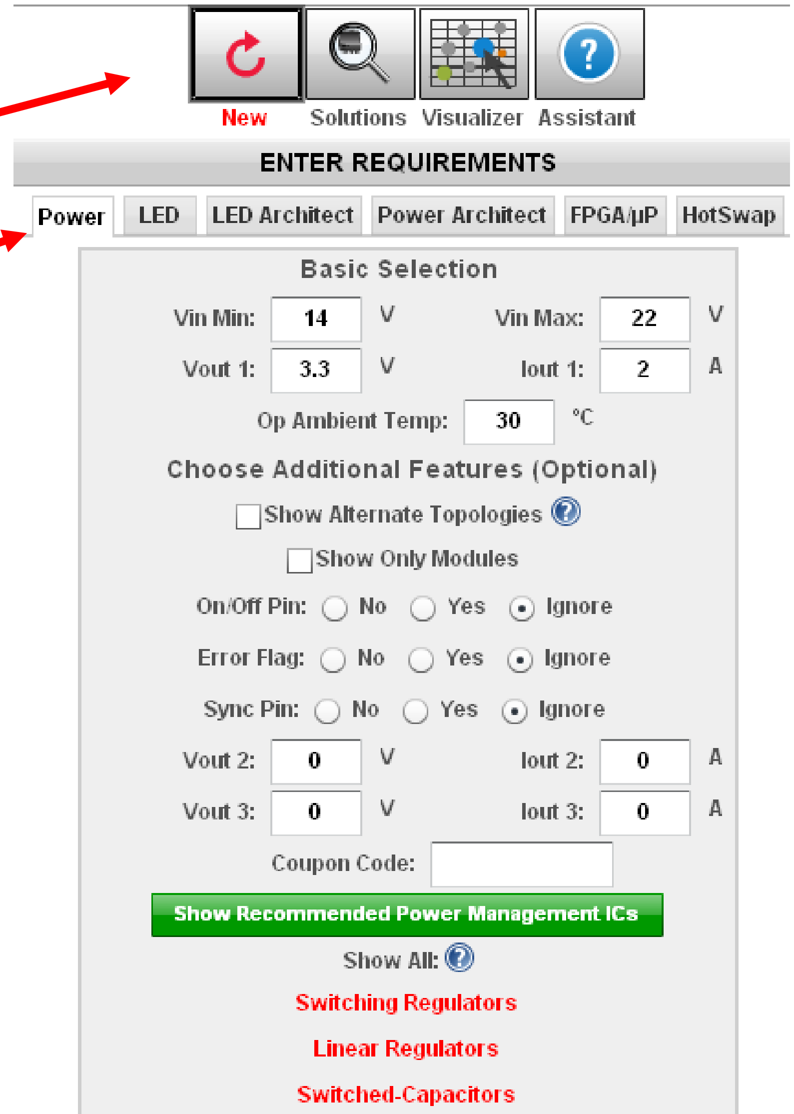
OR

- Go to the product folder for a specific part
- Enter your specifications

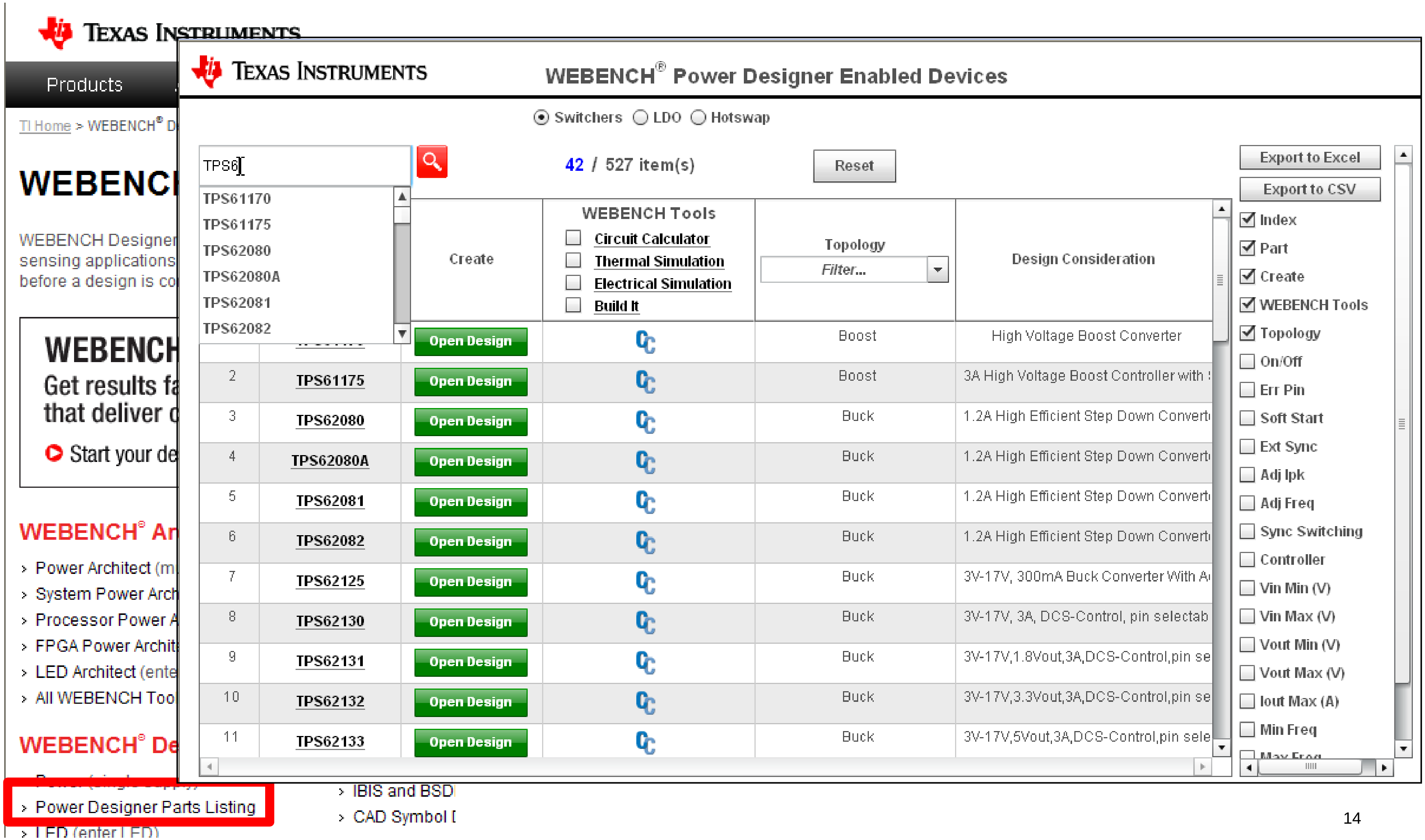
WEBENCH® Navigation

Navigation Icons

WEBENCH Tools:
Power
LED
LED Architect
Power Architect
FPGA / Processor
Power Architect
HotSwap



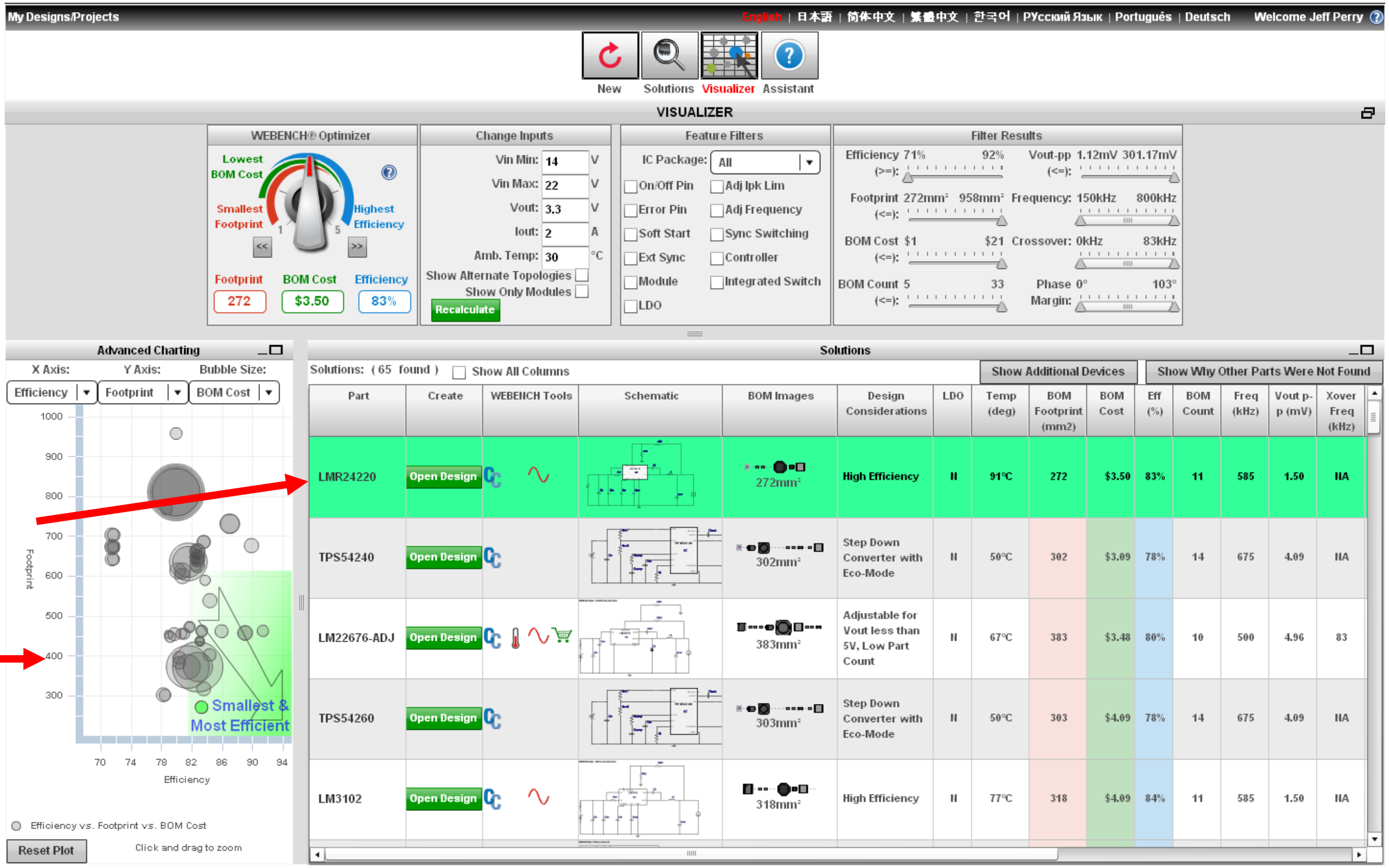
From *webench.ti.com*, Find All Parts Supported by WEBENCH Power Designer



WEBENCH® Visualizer- Calculates 65 Designs in Seconds

Recommended Solutions

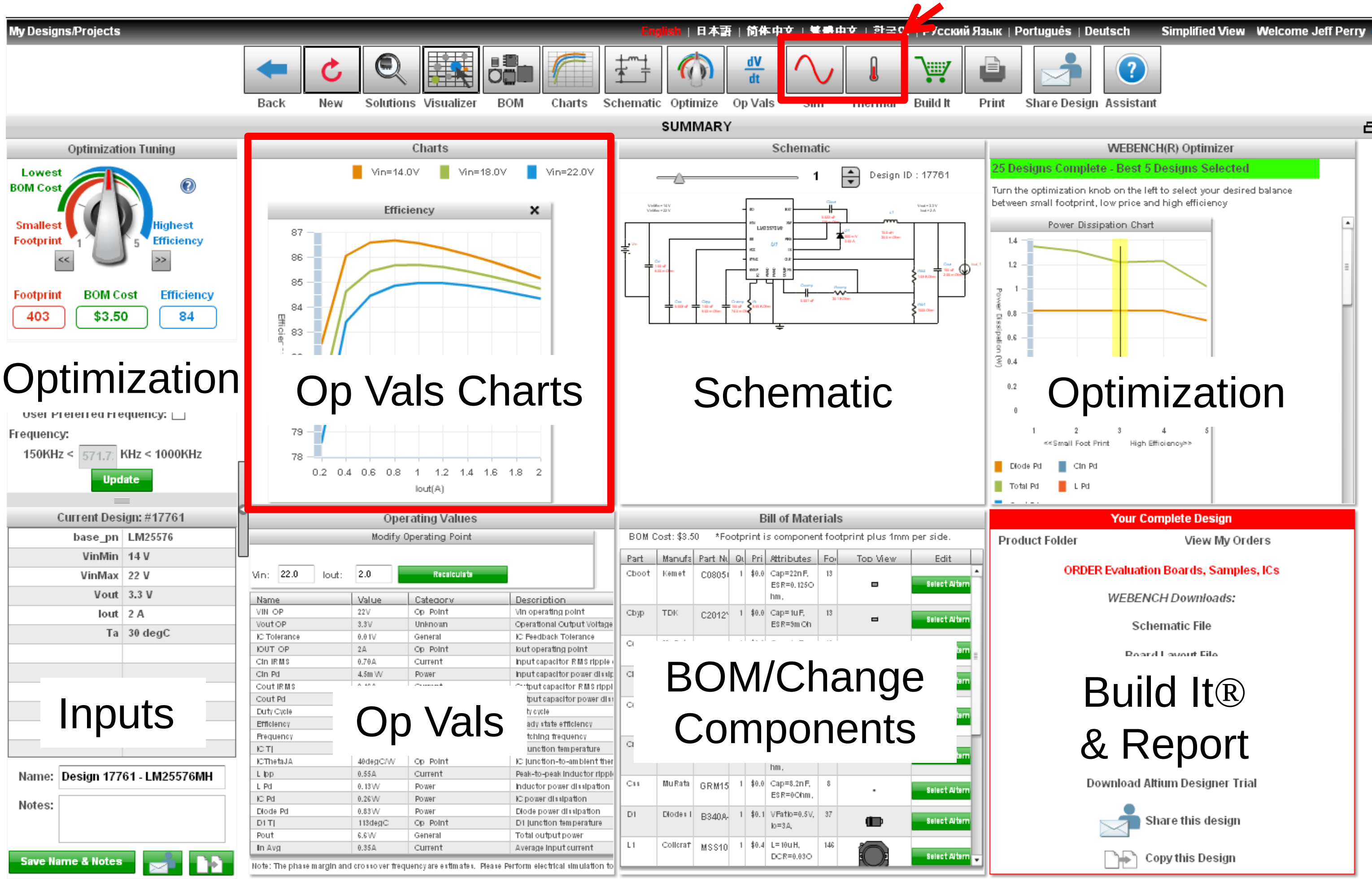
Charts



Create and View Design

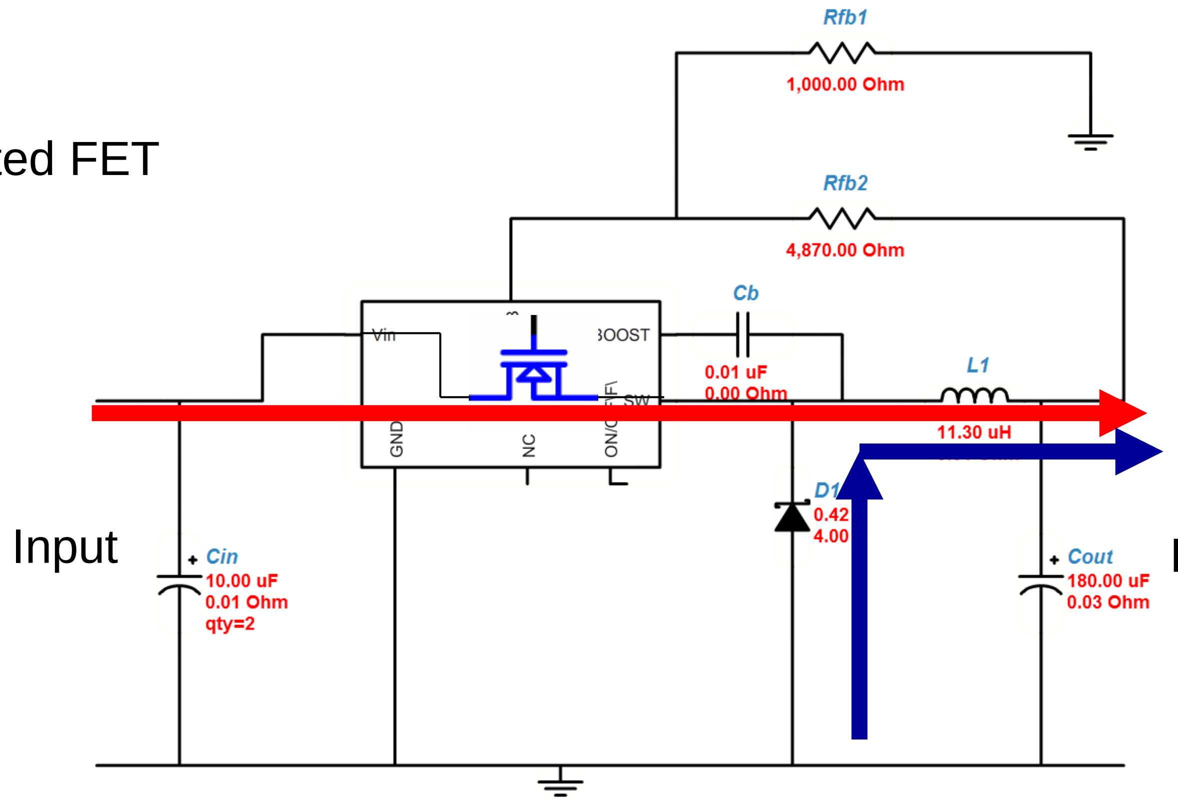
Dashboard
1) Graphs
2) Schematic
3) Optimization
4) Operating values
5) BOM
6) Reporting

Simulation



Schematic – Buck Converter

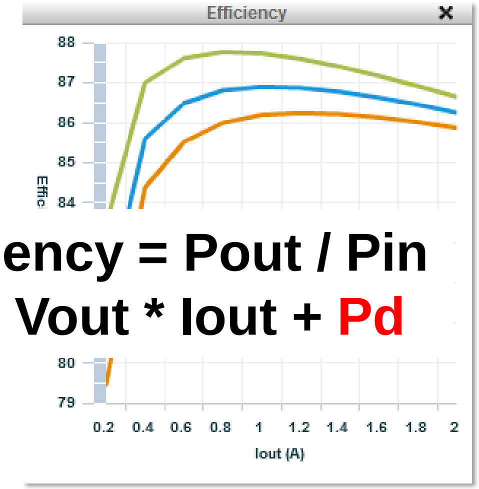
Components:
- Input Capacitor
- Regulator with integrated FET
- Inductor
- Catch Diode
- Output Capacitor
- Feedback Network
- Feature Controls



Current Path with Switch On

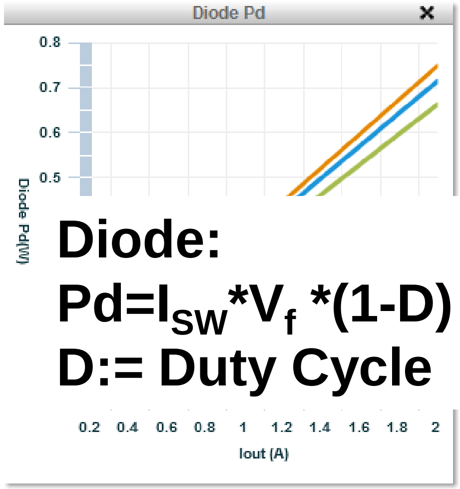
Current Path with Switch Off

Visualize Behavior – Power Dissipation



Efficiency = Pout / Pin

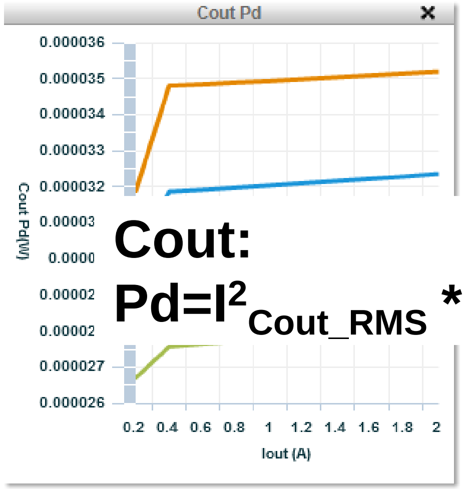
Pin = Vout * Iout + Pd



Diode:

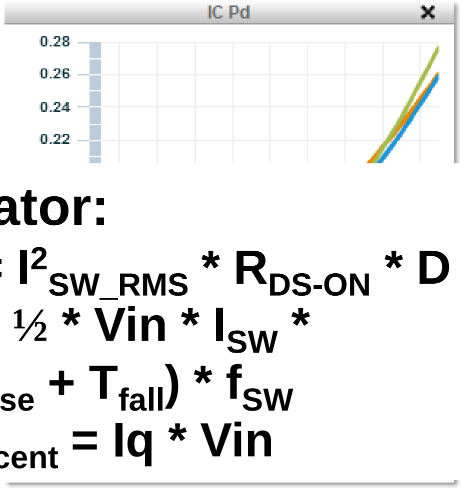
$Pd = I_{SW} * V_f * (1-D)$

D:= Duty Cycle



Cout:

$Pd = I^2_{Cout\_RMS} * ESR$

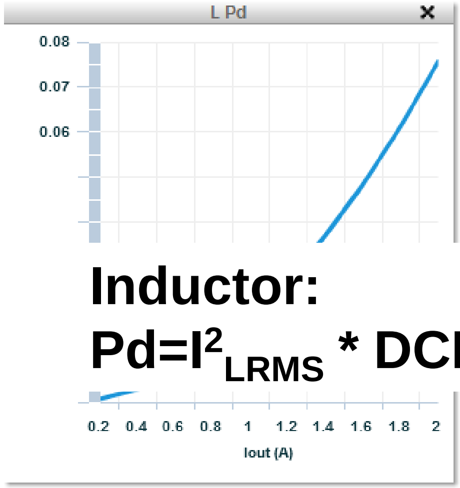


Regulator:

$Pd_{DC} = I^2_{SW\_RMS} * R_{DS\text{-}ON} * D$

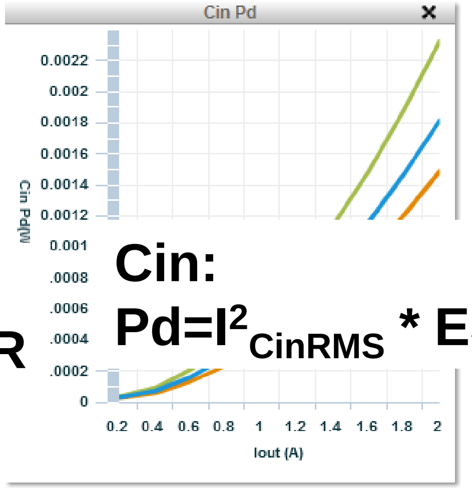
$Pd_{AC} = ½ * Vin * I_{SW} * (T_{rise} + T_{fall}) * f_{SW}$

$Pd_{Quiescent} = Iq * Vin$



Inductor:

$Pd = I^2_{LRMS} * DCR$

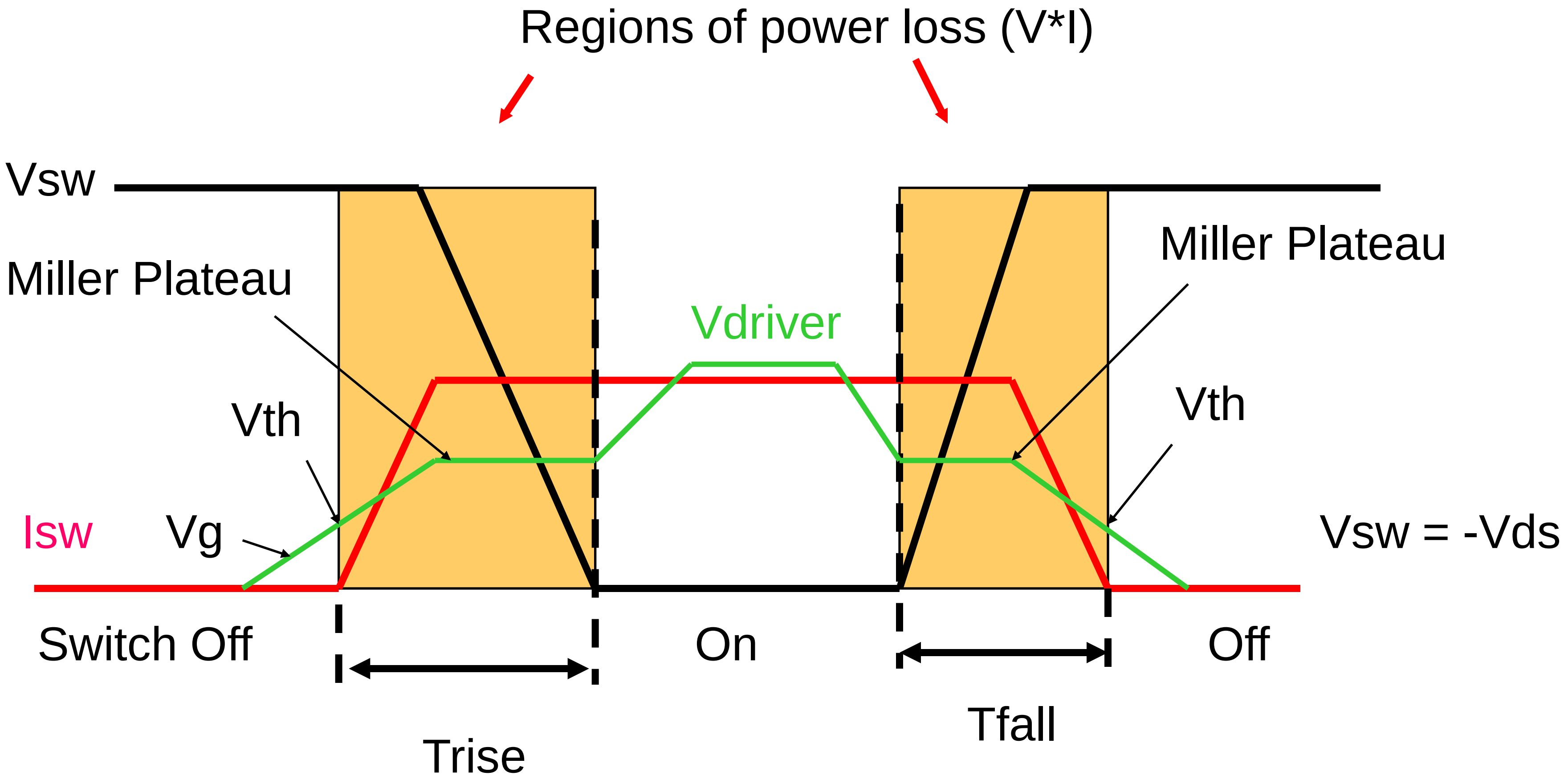


Cin:

$Pd = I^2_{CinRMS} * ESR$

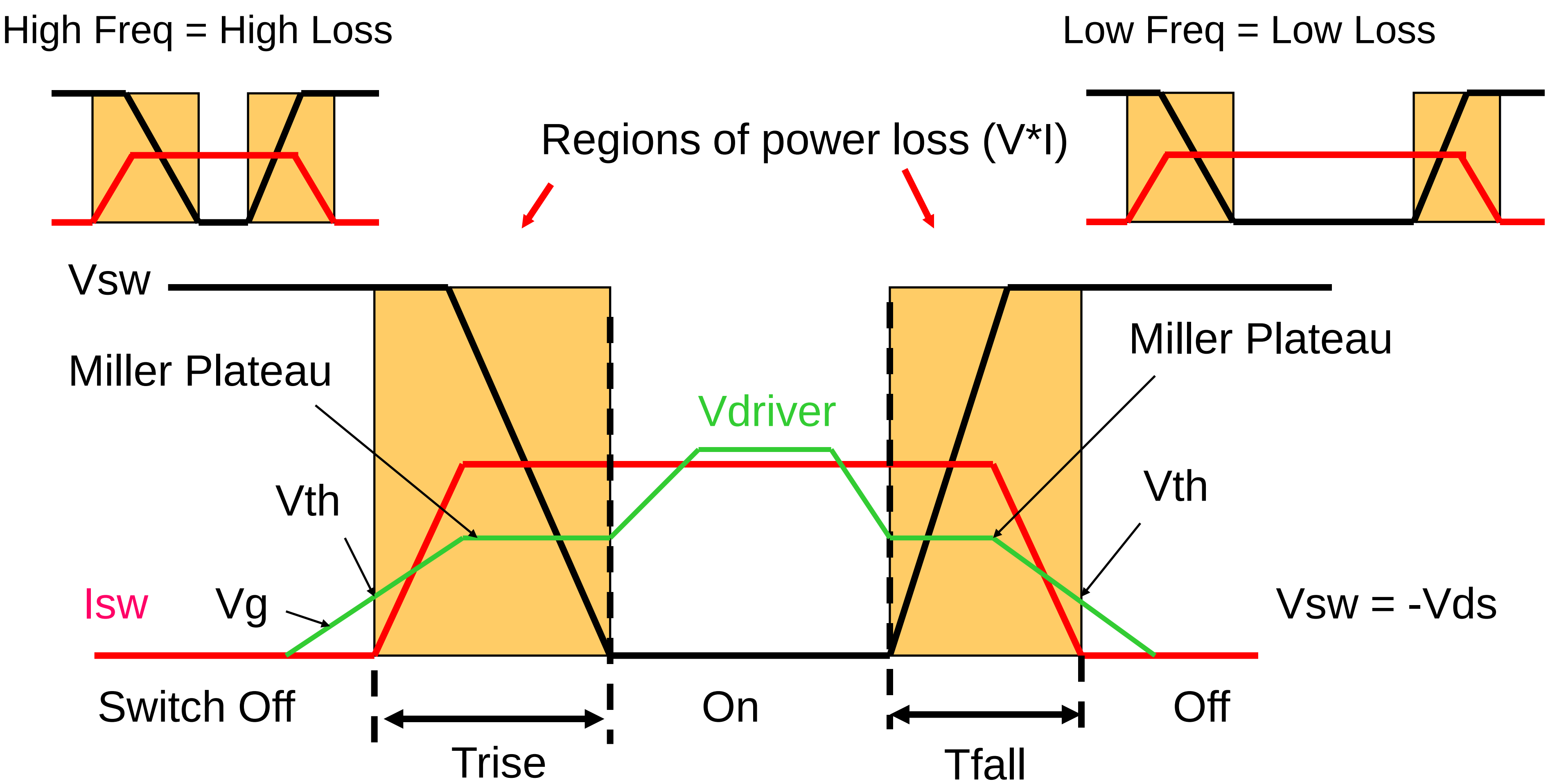
FET Selection: AC Loss

- **PswAC = ½ * Vds$_{off}$ * Ids$_{on}$ * (trise + tfall)/Tsw**



FET Selection: AC Loss

- **PswAC = ½ * Vds_{off} * Ids_{on} * (trise + tfall)/Tsw**



Texas Instruments

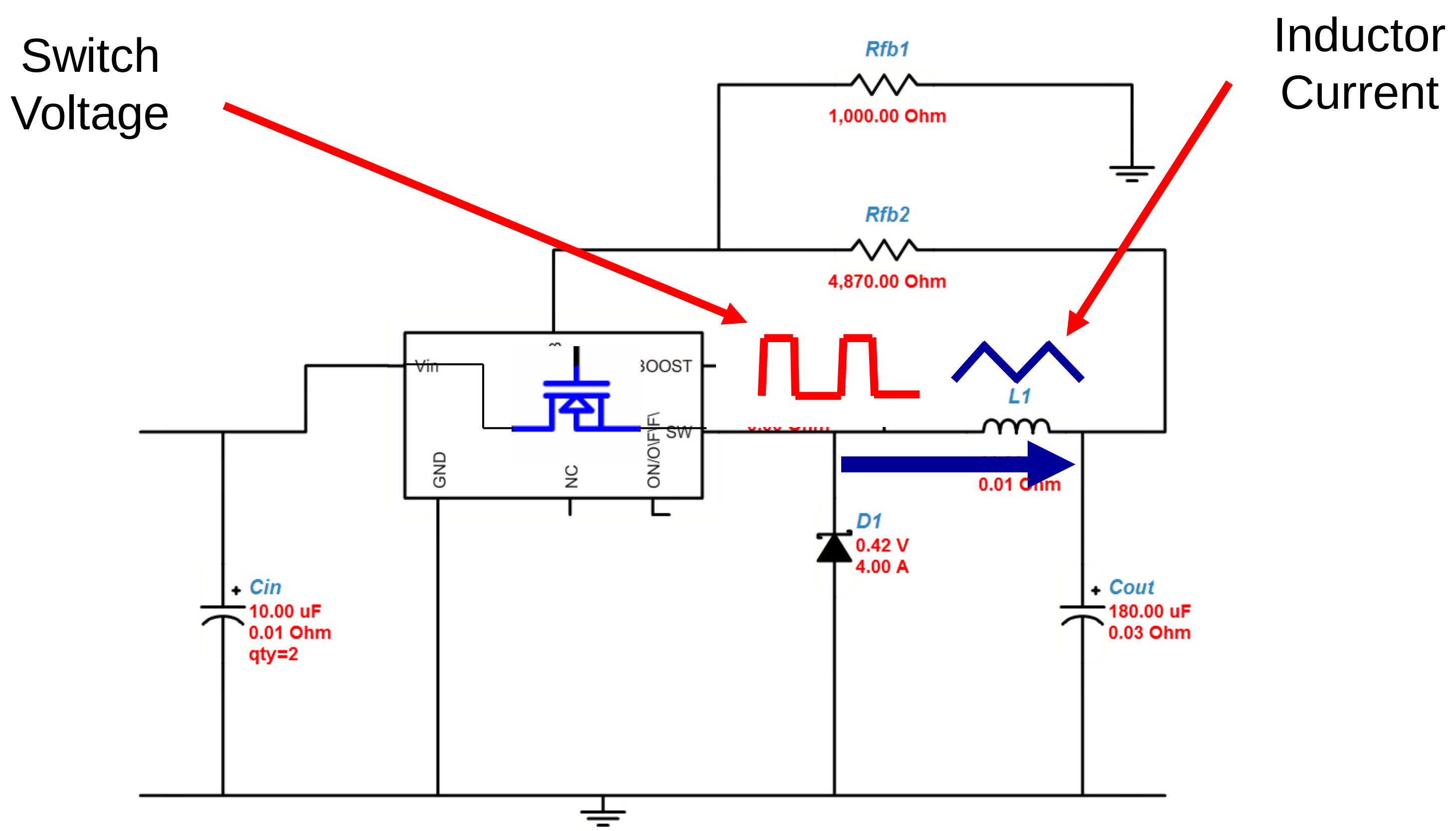
How to Reduce FET Power Loss

- **DC losses: Choose a FET with low RdsOn**
- **AC losses: Choose a FET with low gate charge**
- **AC losses: Lower the switching frequency**

BUT

- **Lowering frequency affects the inductor selection**
- **We want to keep the inductor ripple current constant**
  - **Because this changes the peak switch current and the Vout ripple**

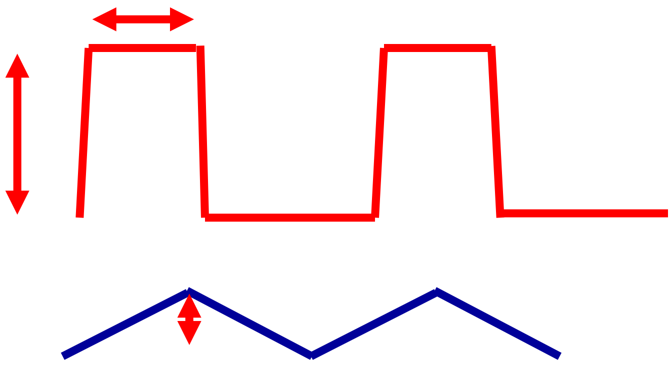
Inductor Current vs. Switch Voltage



Inductor Ripple Current

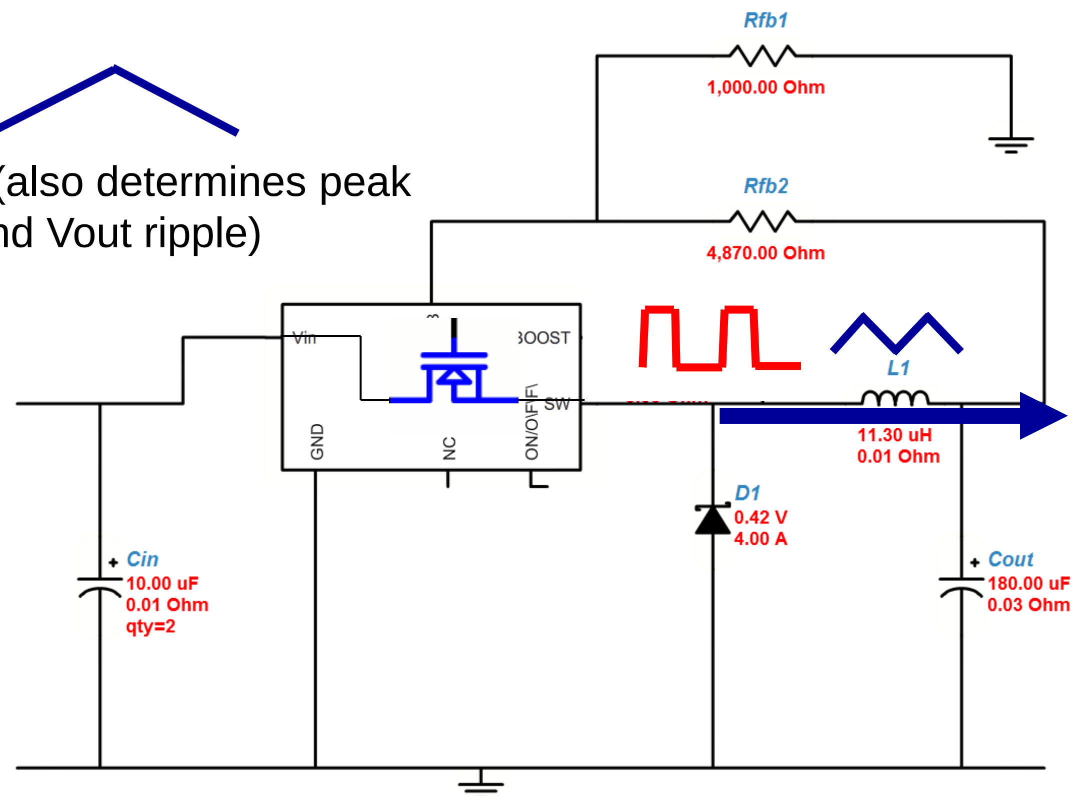
On
Time

Voltage
applied



$dI = (1/L)*V*dt$

Inductor Ripple Current (also determines peak switch current and Vout ripple)

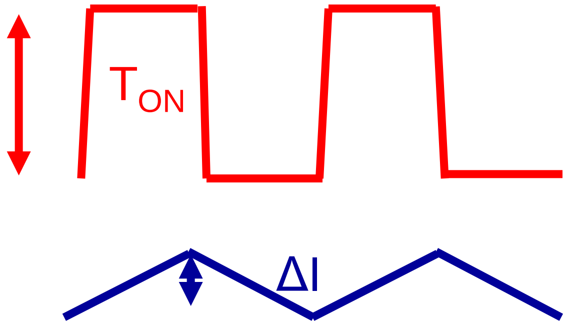


Inductor Selection – Lower Frequency

Higher frequency:

On Time

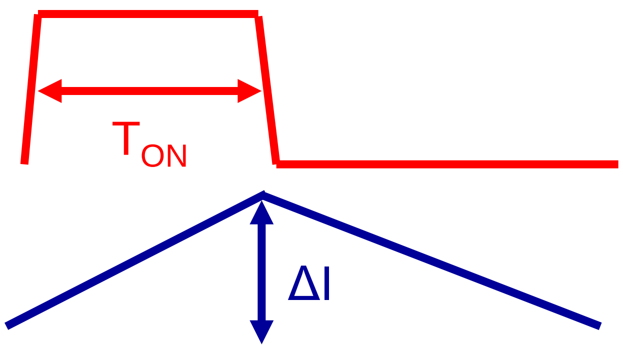
Voltage applied



dI = (1/L)*V*dt

Inductor Ripple Current (also determines peak switch current and Vout ripple)

Lower frequency:



If L is kept constant, ILpp increases

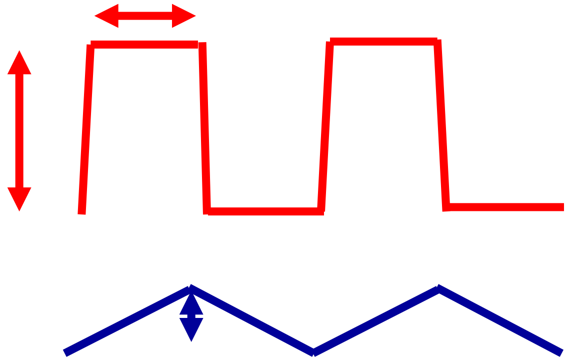
Lower Frequency = Increased On Time = Increased Inductor Ripple Current = Increased Peak Switch Current and Increased Vout Ripple

Inductor Selection – Raise Inductance

Higher frequency:

On Time

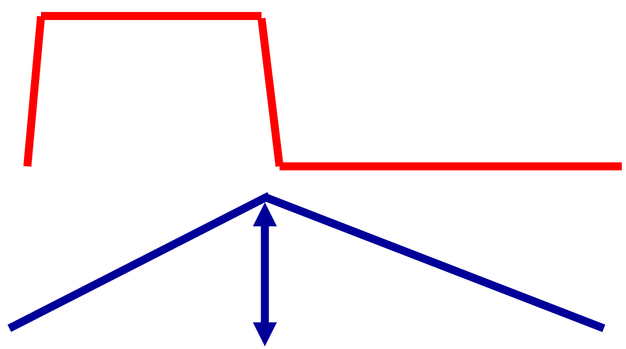
Voltage applied



dI = (1/L)*V*dt

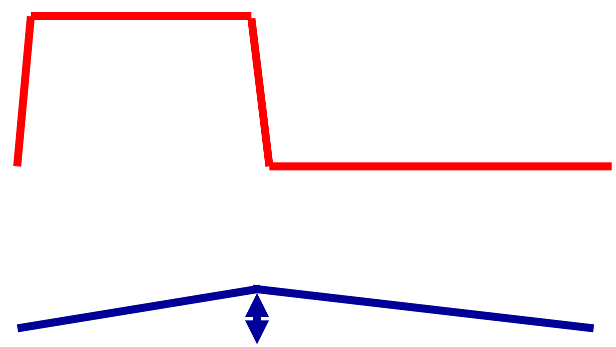
Inductor Ripple Current (also determines peak switch current and Vout ripple)

Lower frequency:



If L is kept constant, ILpp increases

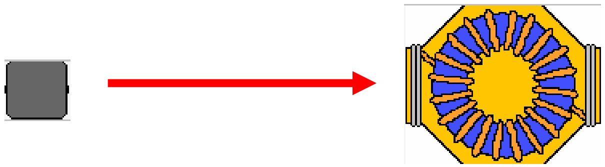
Lower frequency with higher inductance:



So we need to increase L

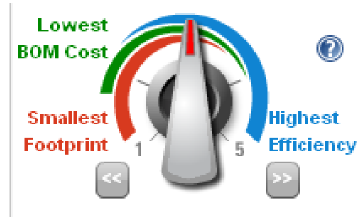
Effect of Lower Frequency on Inductor

- **If we keep the inductor ripple current constant by increasing the inductance:**
  - **The inductor gets larger (more turns)**
  - **The inductor power dissipation goes up (longer wire)**



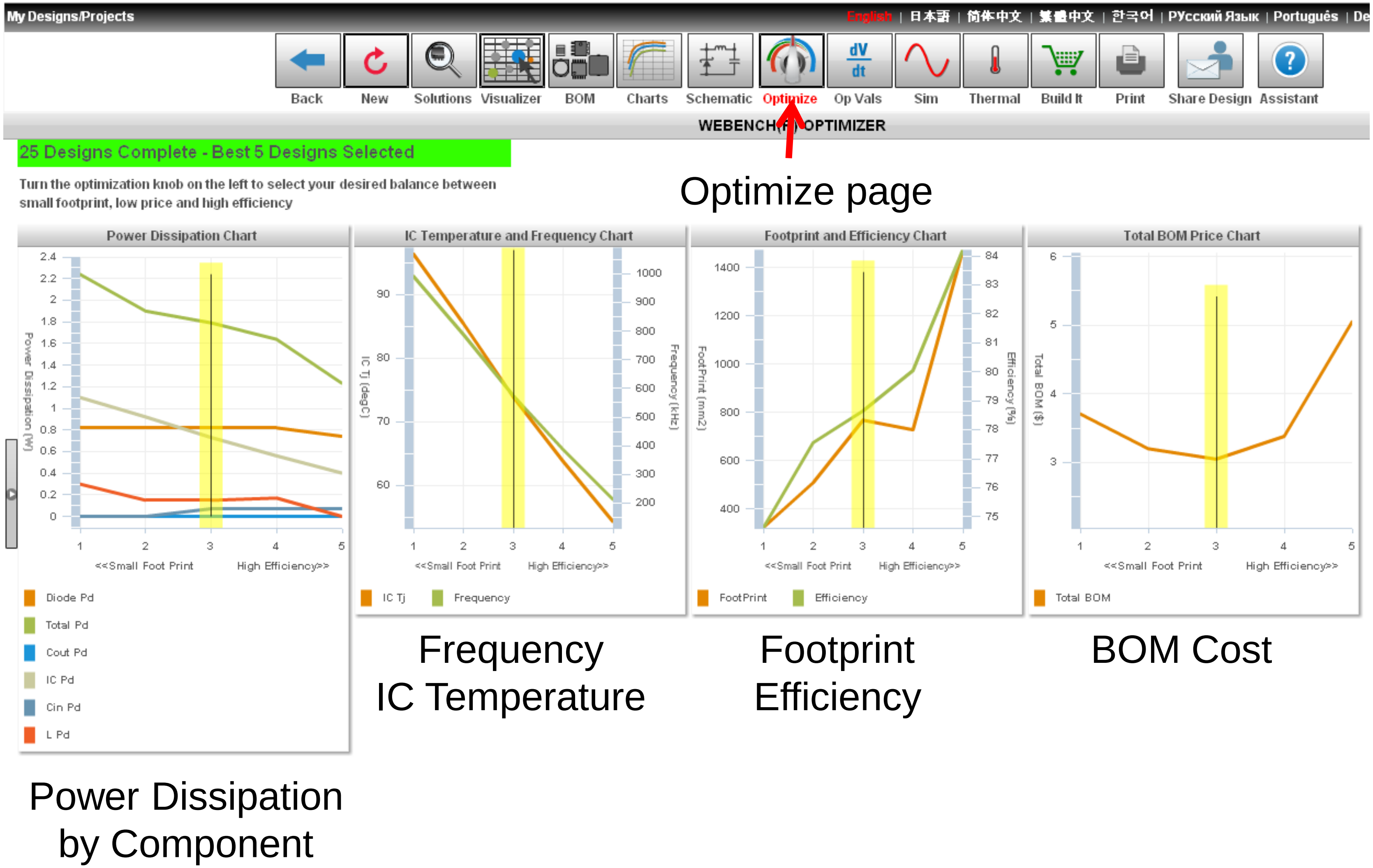
WEBENCH® Optimizer Dial
"Dial In Your Solution"

WEBENCH® Design Optimization

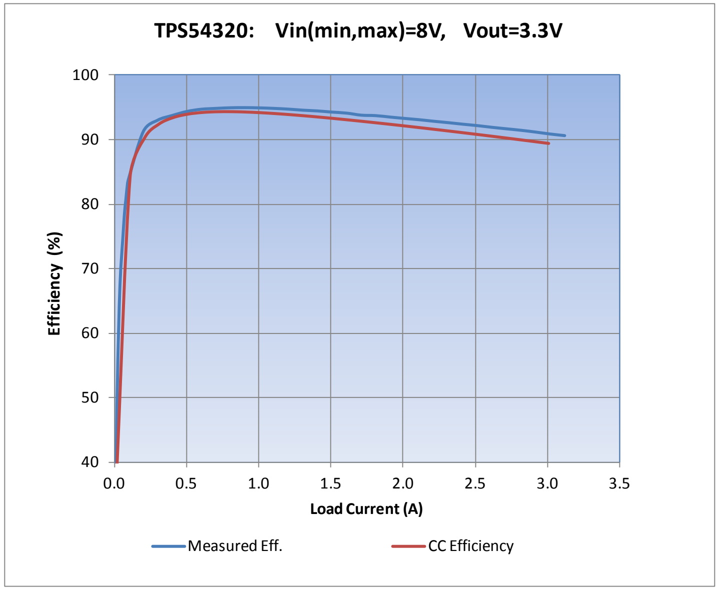


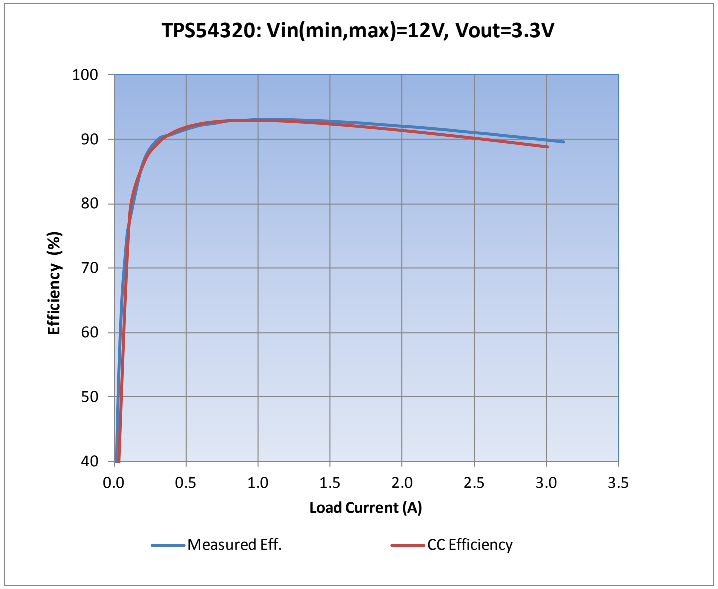
Optimization Setting	Frequency	Component Selection	Summary
1 – Smallest footprint	Highest	• Smallest footprint • Don’t care about cost	Smallest size but lowest efficiency
2 – Lowest cost	High	• Lowest cost	High frequency means smaller / cheaper components
3 – Balanced	Medium	• In stock • Low cost	Balanced approach using IC’s middle frequency
4 – High efficiency	Low	• Low DCR, ESR, Vf • Low cost	Higher efficiency, with low cost but larger parts
5 – Highest efficiency	Lowest	• Low DCR, ESR, Vf • Don’t care about cost	Highest efficiency but largest parts

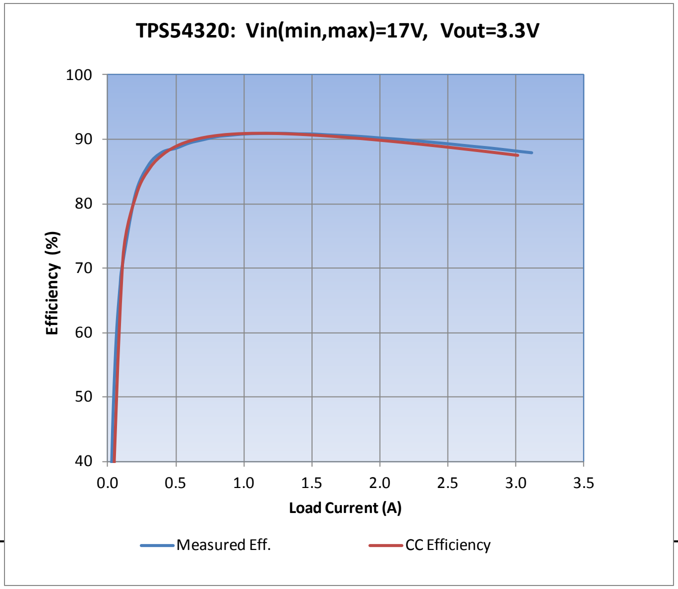
Key Optimization Parameters Graphed



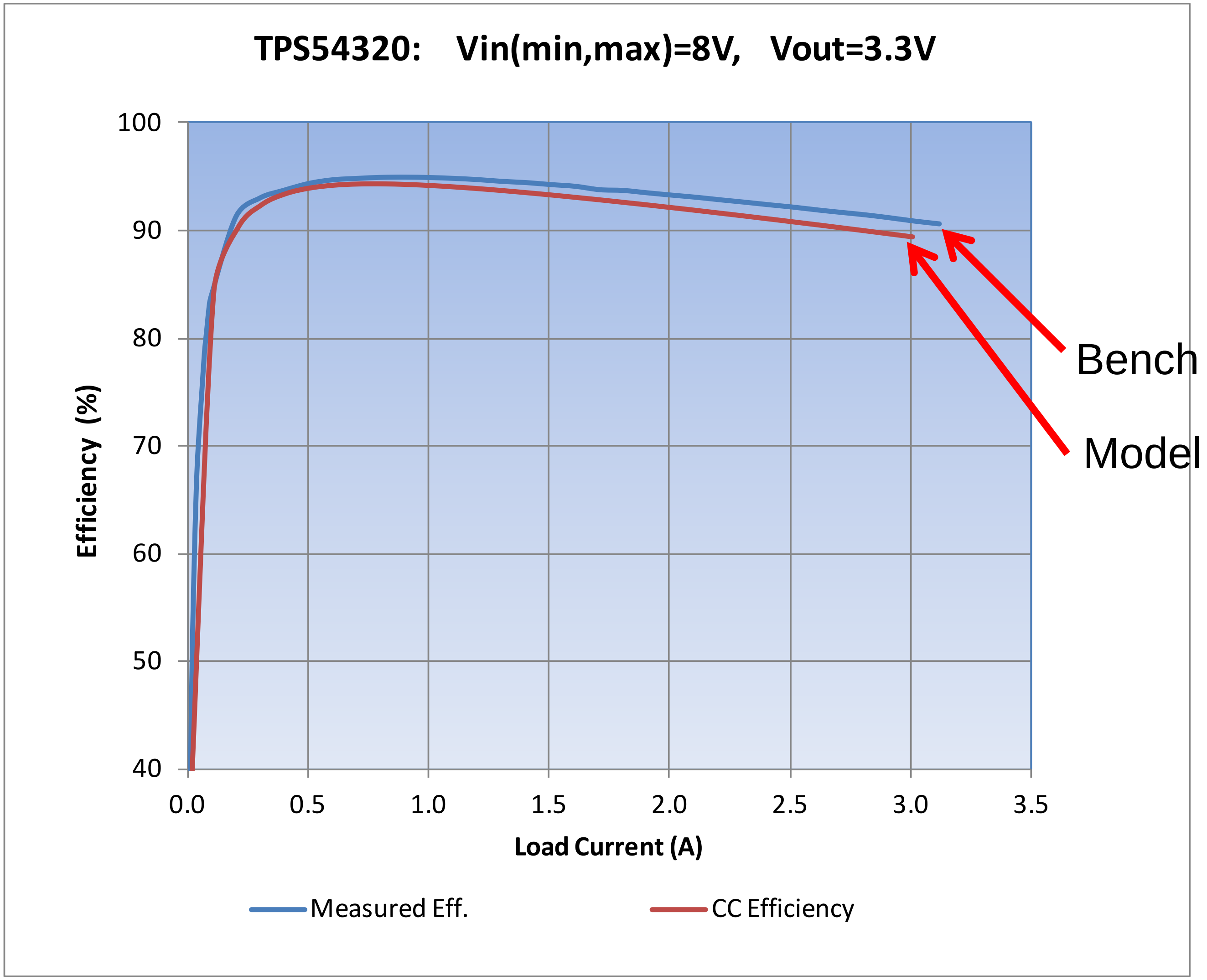
WEBENCH® Efficiency Verification





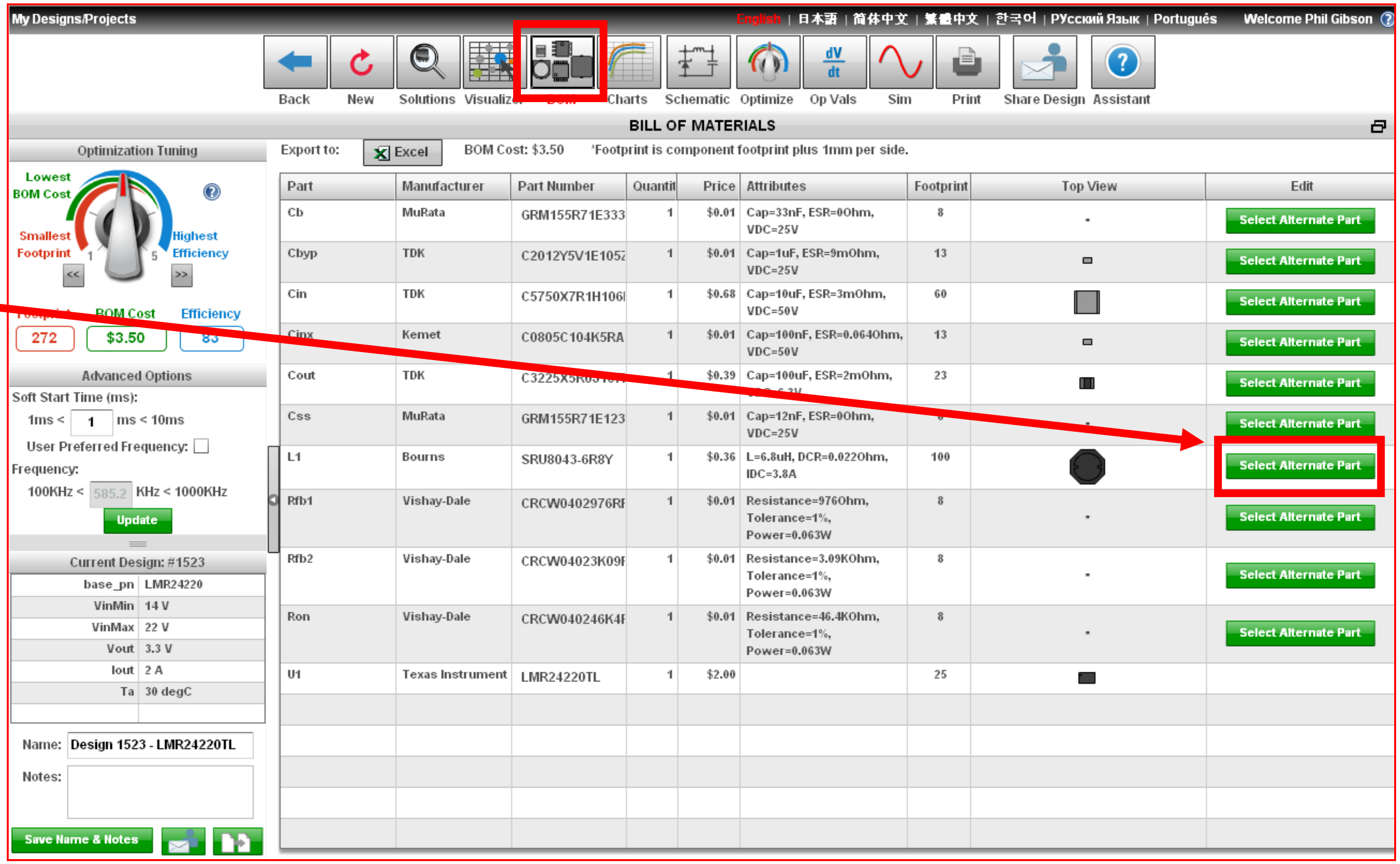


WEBENCH® Efficiency Verification



Continue to Improve Your Design: View and Change Your Bill of Materials

Click Select Alternate To Change A Component

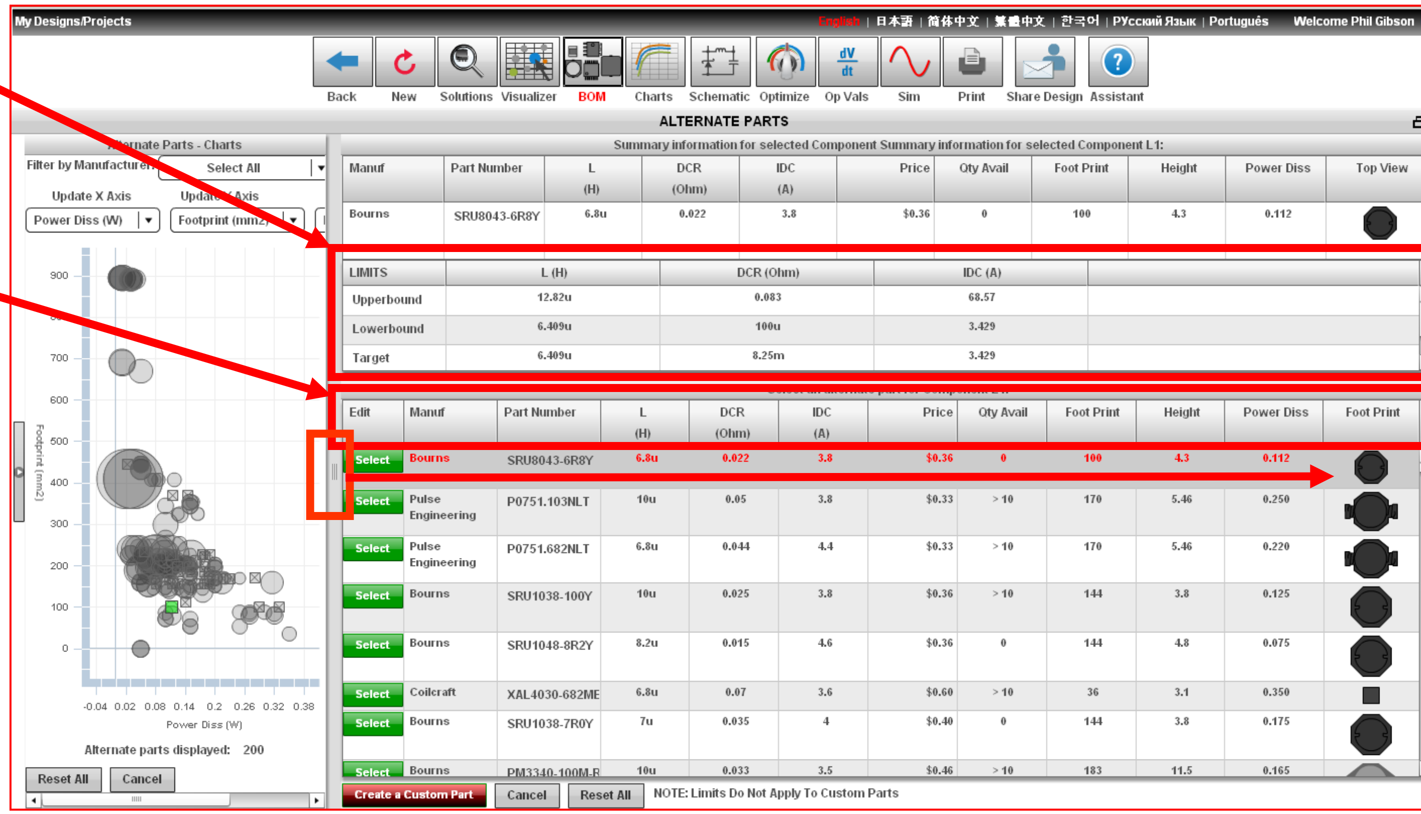


Evaluate and Select Alternate Components

Parameter Specification Limits

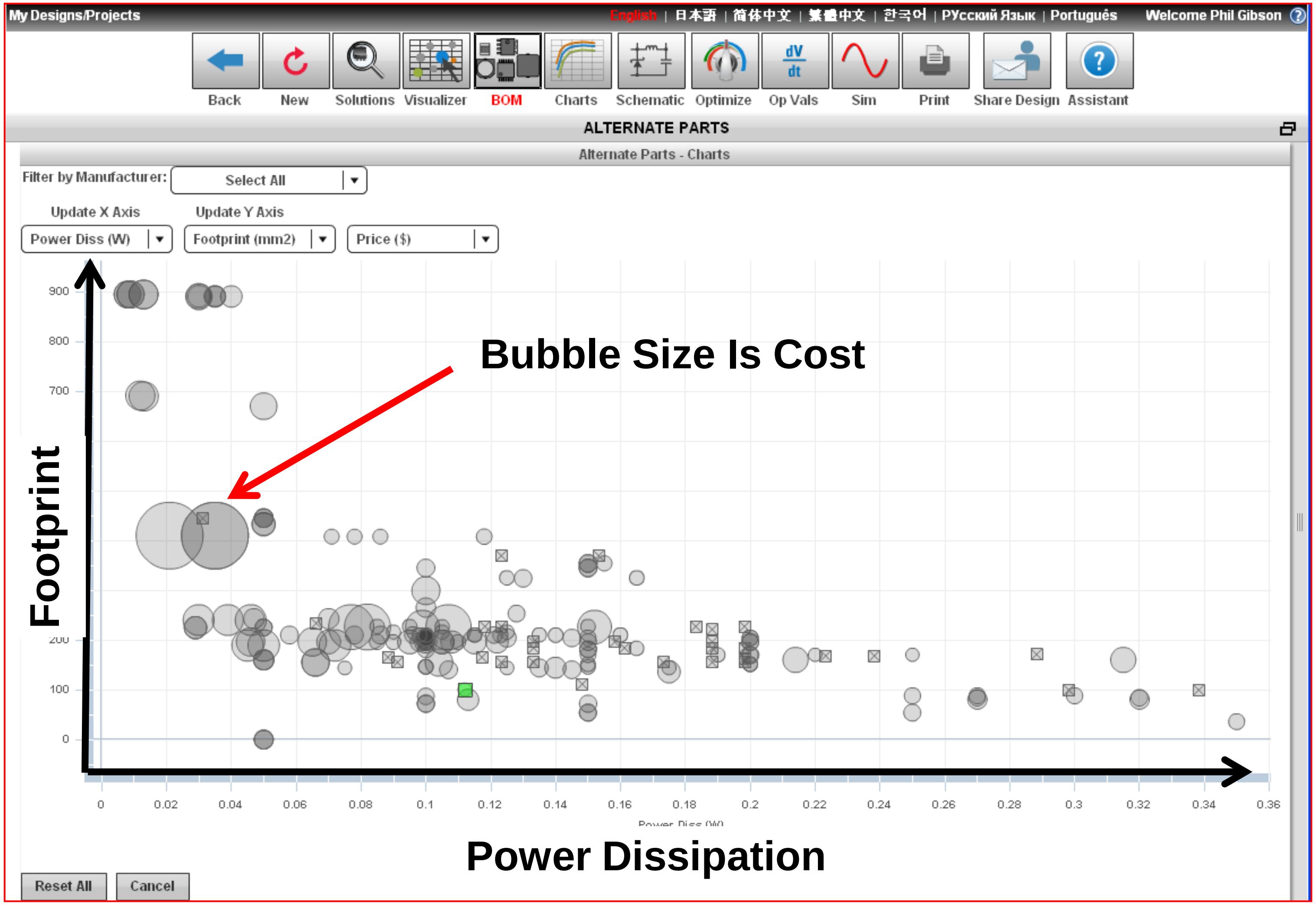
Multiple Column Sort

Component Tradeoffs:
- Footprint
- Pdiss
- Price
- Performance
  - Vout Ripple
  - Transient Resp
  - Loop Stability

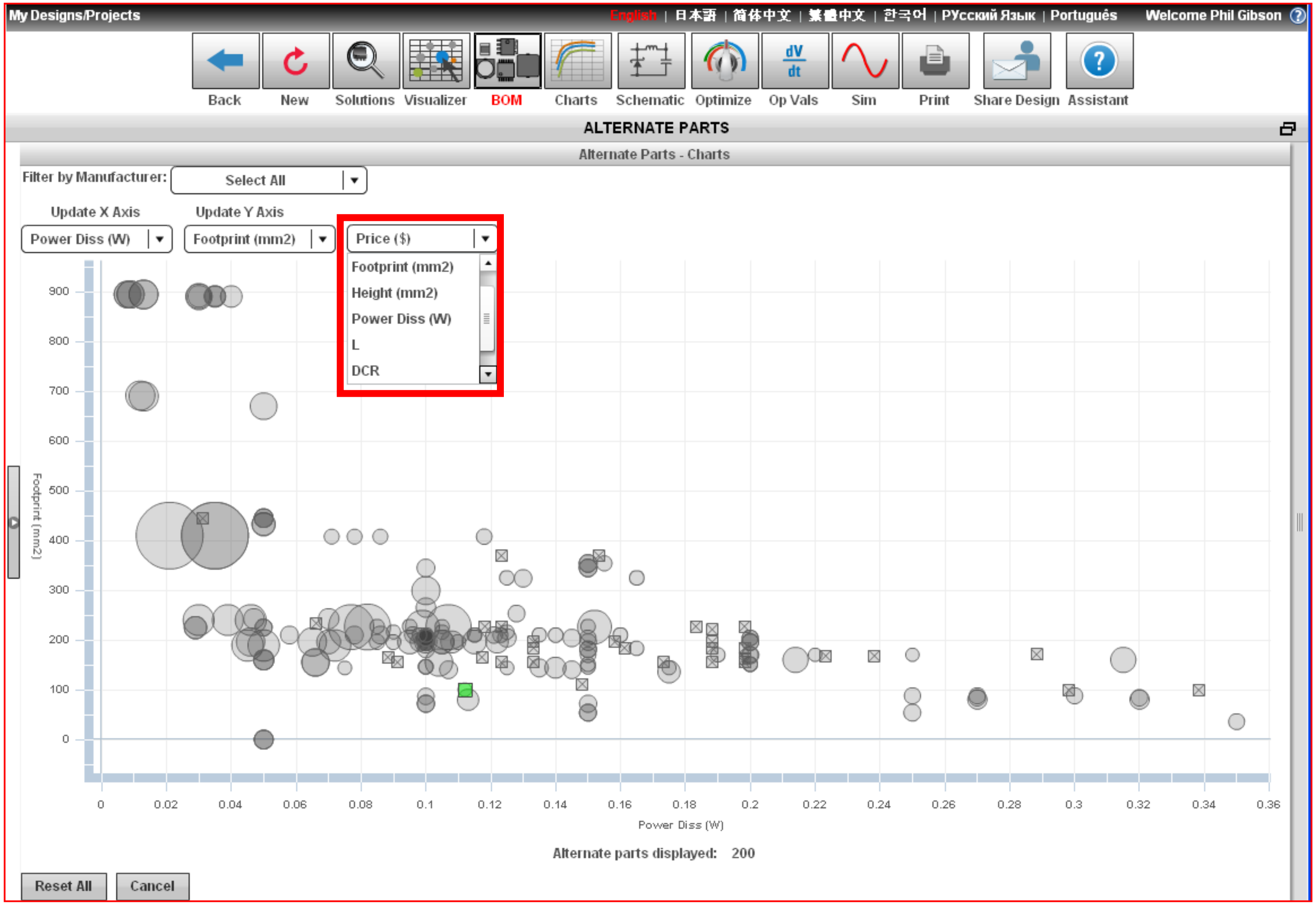


TEXAS INSTRUMENTS

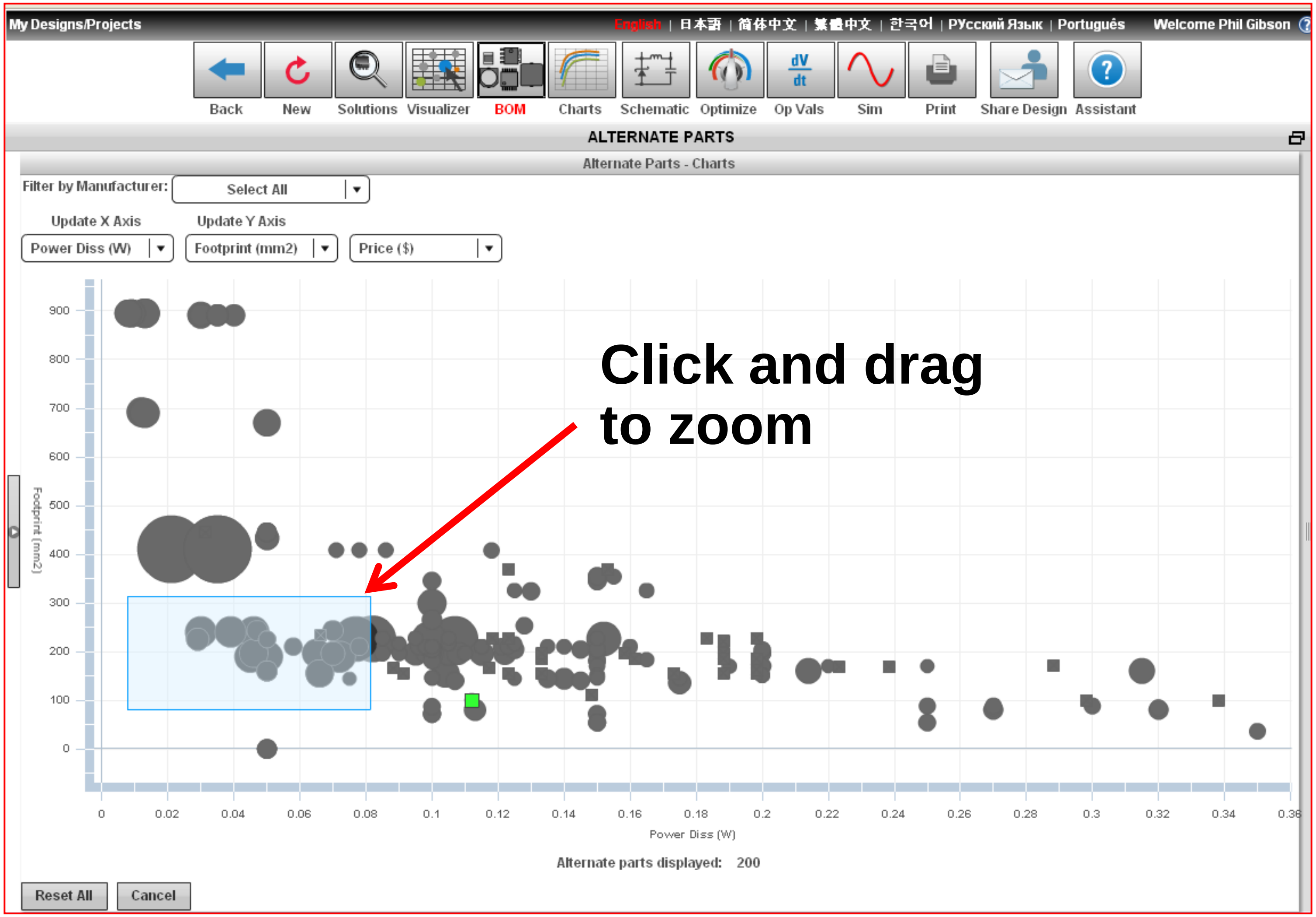
Evaluate Components - Inductor



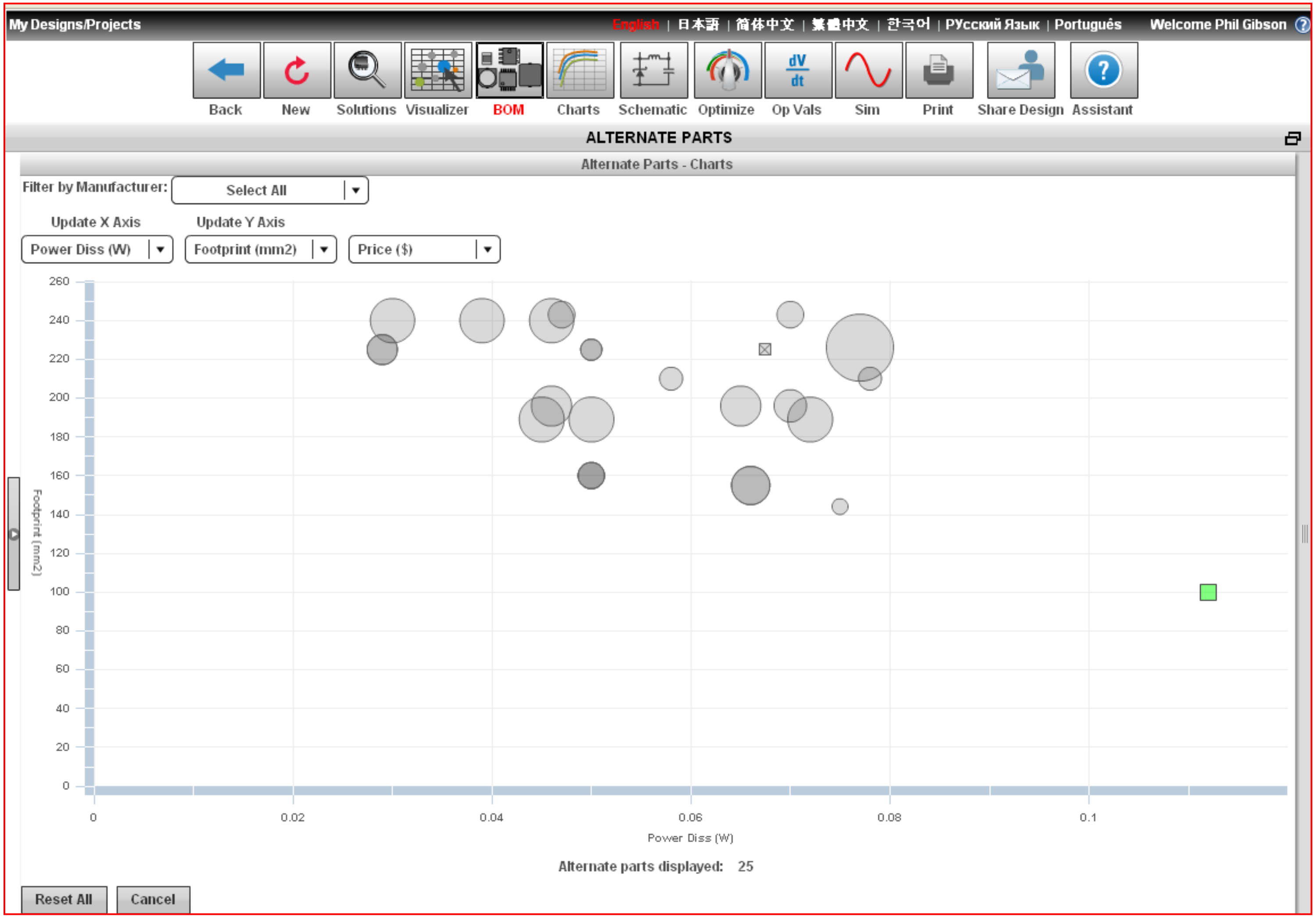
Change Perspective - Inductor



Evaluate Components – Zoom to Highlight for More Detail



Evaluate Components – Zoom to Highlight

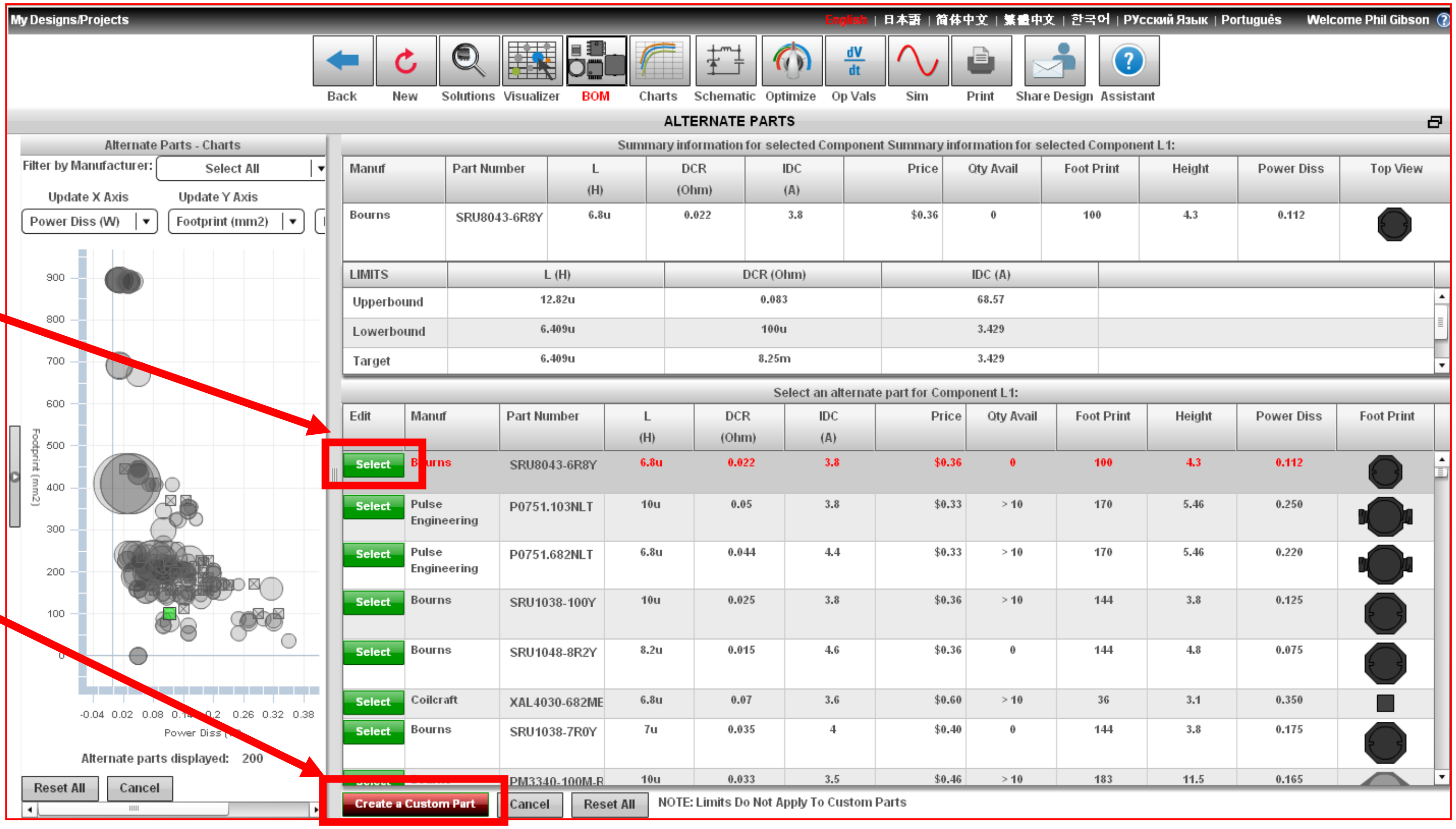


Select New Component

Filtered list based on zoom box

Click to select a component

Or create a custom component



Texas Instruments

Hands-on Exercise:

Design Problem:	Goals:
Management has requested a design using the LM22680: Create the following design: Vin: 14-22V Vout: 3.3V Iout: 2A	Try optimization knob settings 1 and 5 and note: Frequency Footprint BOM cost Efficiency

Why Do Electrical Simulation?

Identify Problems

- **Design has been configured for stable operation BUT**
- **May want to verify under dynamic conditions**

Try Solutions

- **Improve line/load transient response**
- **Minimize output voltage ripple**
- **Modify control loop**

Visualize Results

- **Interactive waveform viewer allows detailed analysis of results**

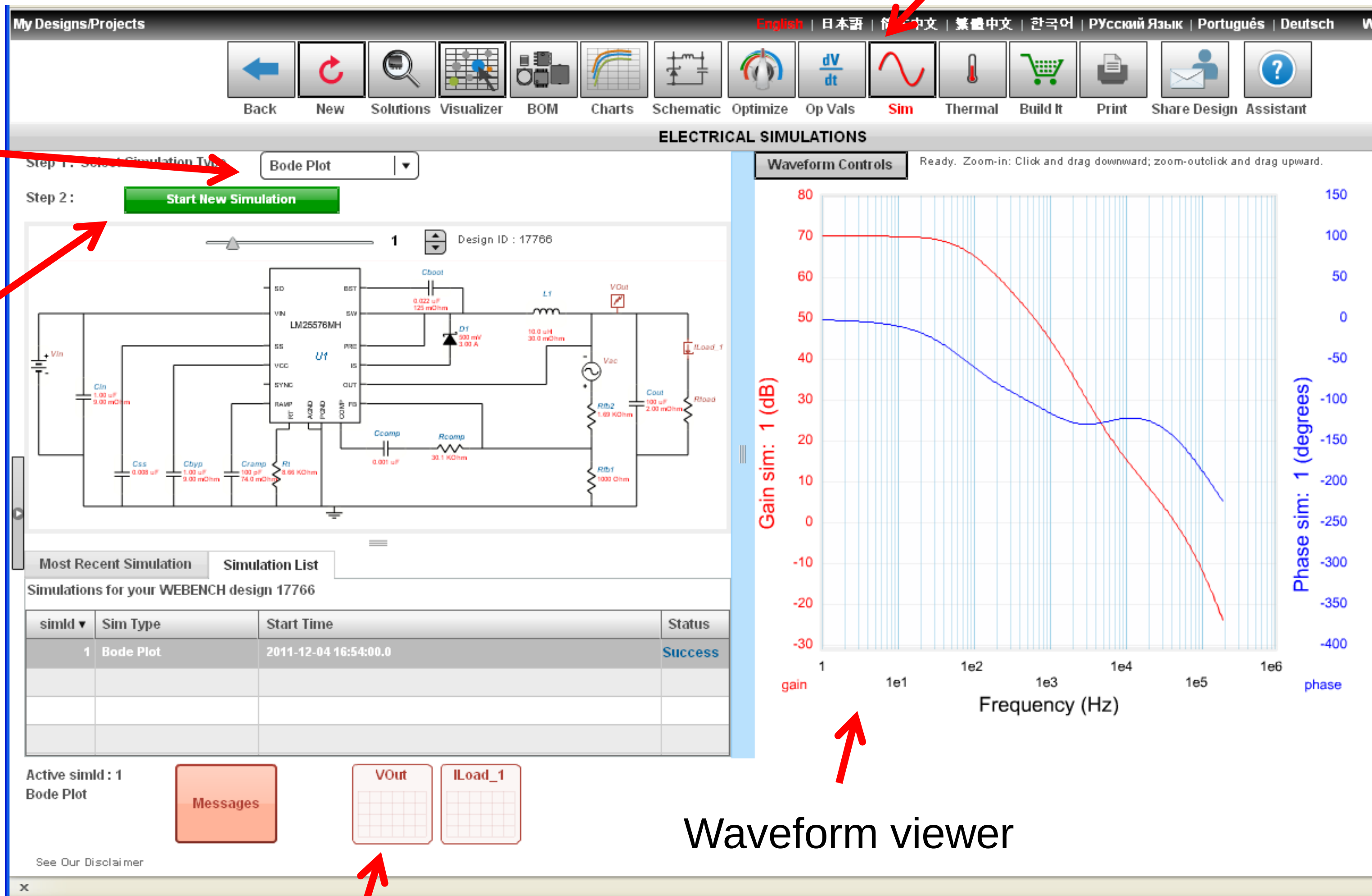
Electrical Simulation

Esim page

Specify sim type

Click start to initiate sim

- Bode Plot
- Line Transient
- Load Transient
- Startup
- Steady State



Waveform viewer

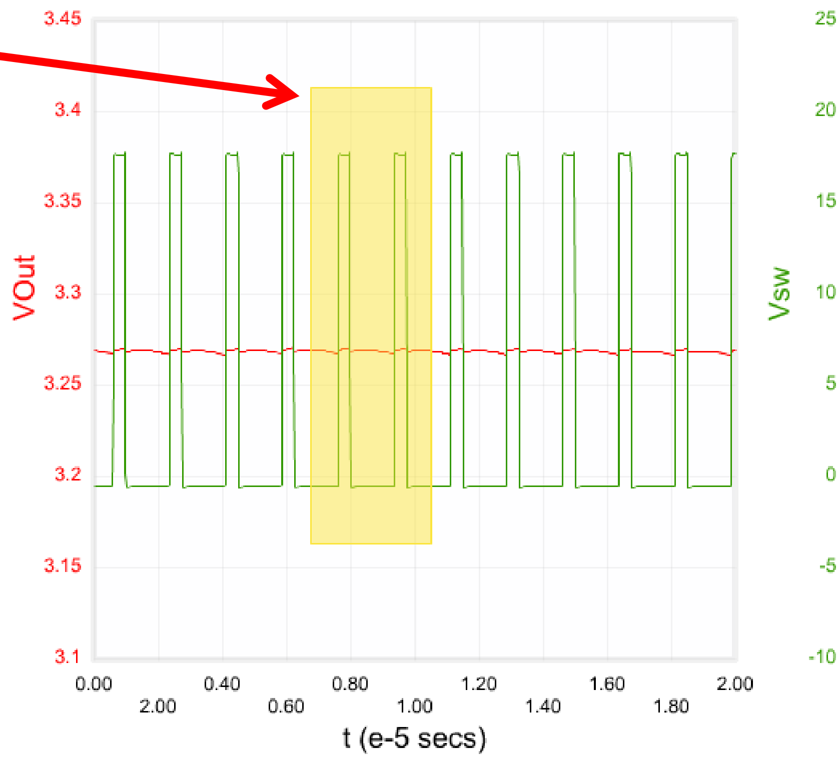
Click to view waveforms

Texas Instruments

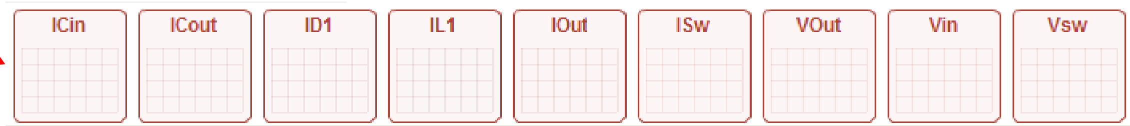
Waveform Viewer

Click and drag down and to the right to zoom in

Click and drag up and to the left to zoom out



Click on a tile to add a waveform

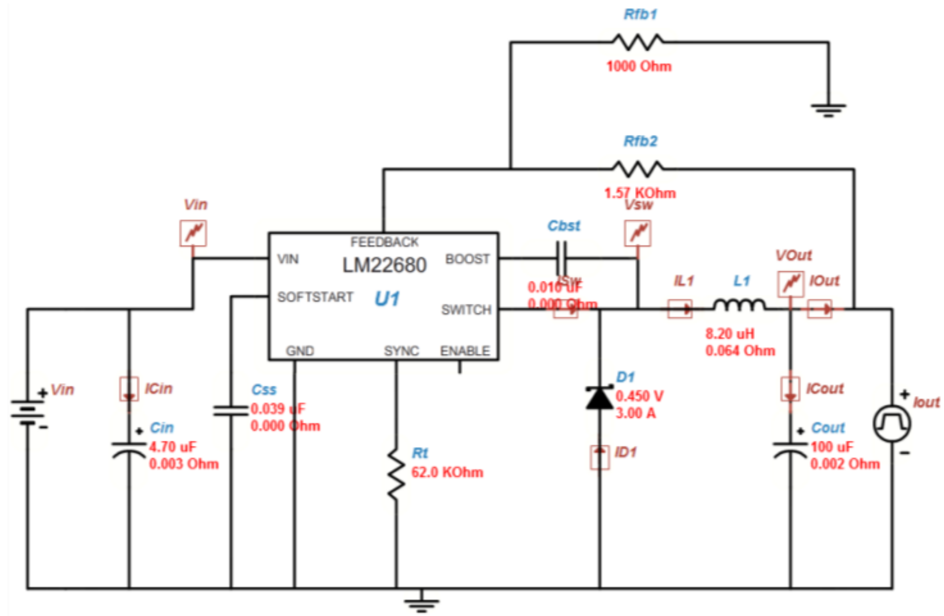


Evaluate Transient Response

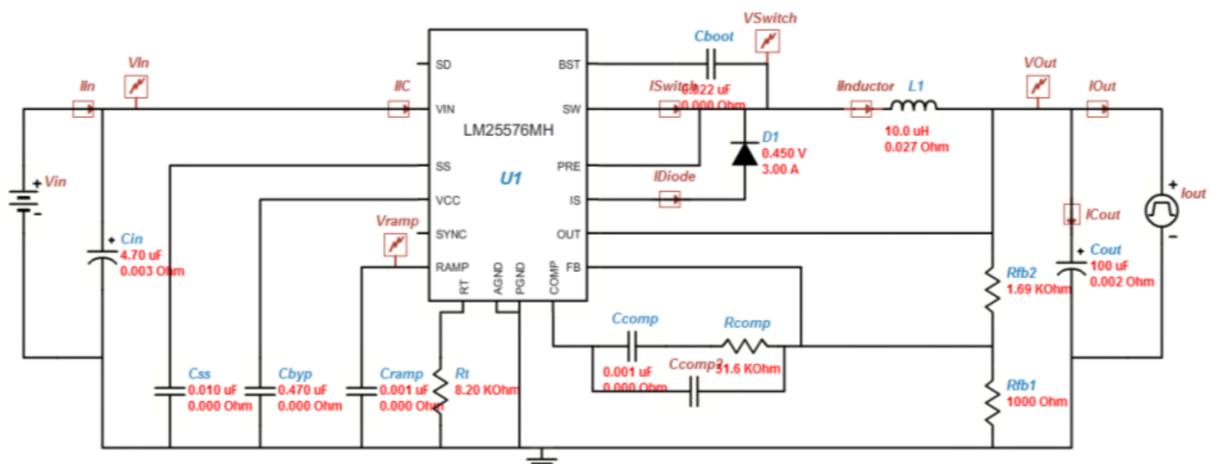
- LM22680
  - Voltage mode pulse width modulation control scheme (PWM)
  - Lower part count – SIMPLE SWITCHER®
- LM25576
  - Emulated current mode (ECM)
  - Fast transient response
- Will evaluate:
  - How does ECM compare with PWM
  - Vin: 14-22V, Vout: 3.3V, Iout: 2A

Buck Schematics

LM22680 PWM

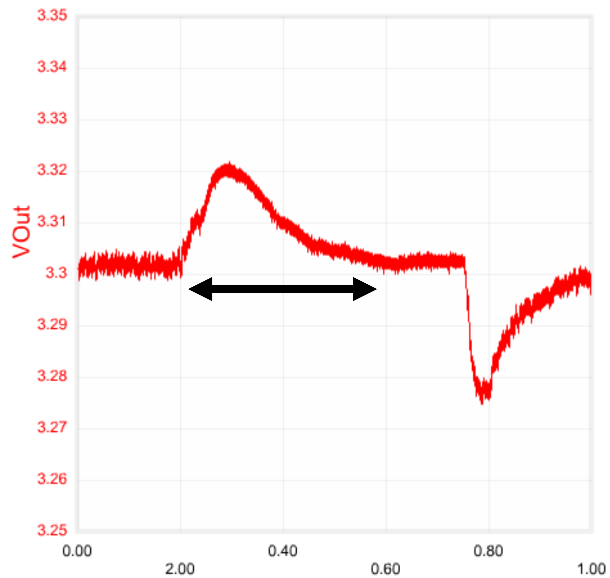


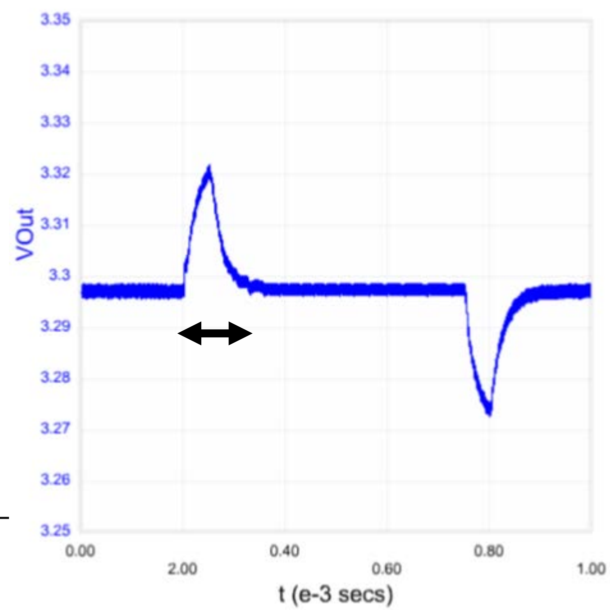
LM25576 ECM



LM22680 vs. LM25576
Vout for Load Transient

- LM22680 (Pulse Width Modulated)



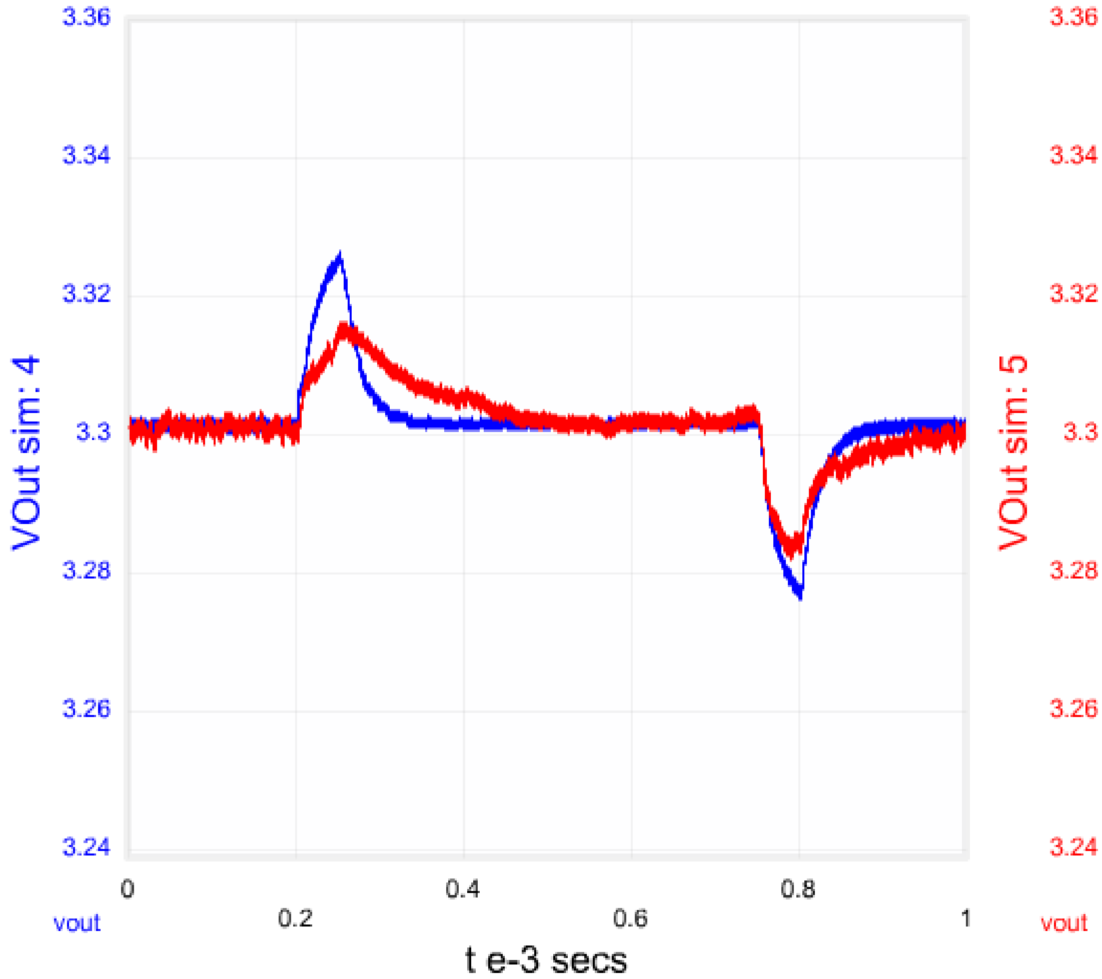


- LM25576 (Emulated Current Mode) has faster transient response recovery time

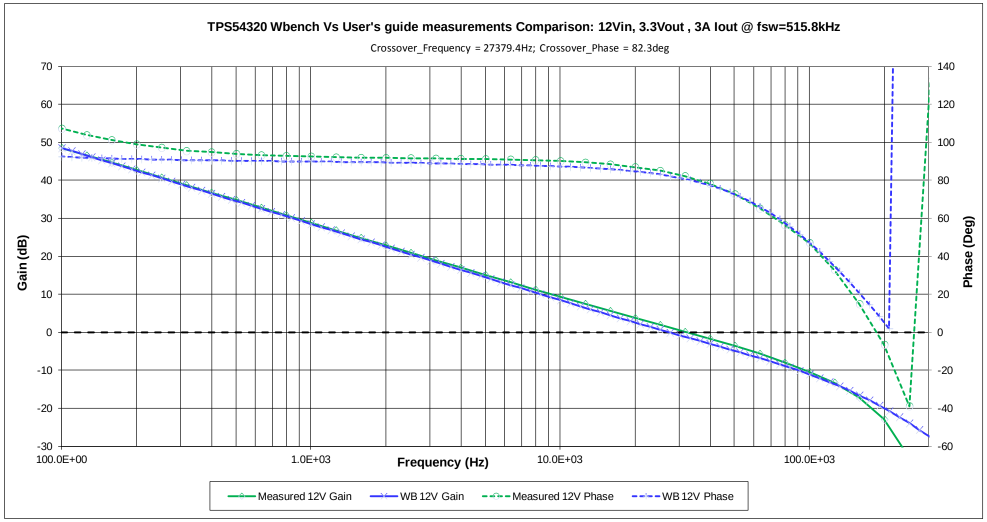
Load Transient:
.2 – 2A
50usec rise/fall time

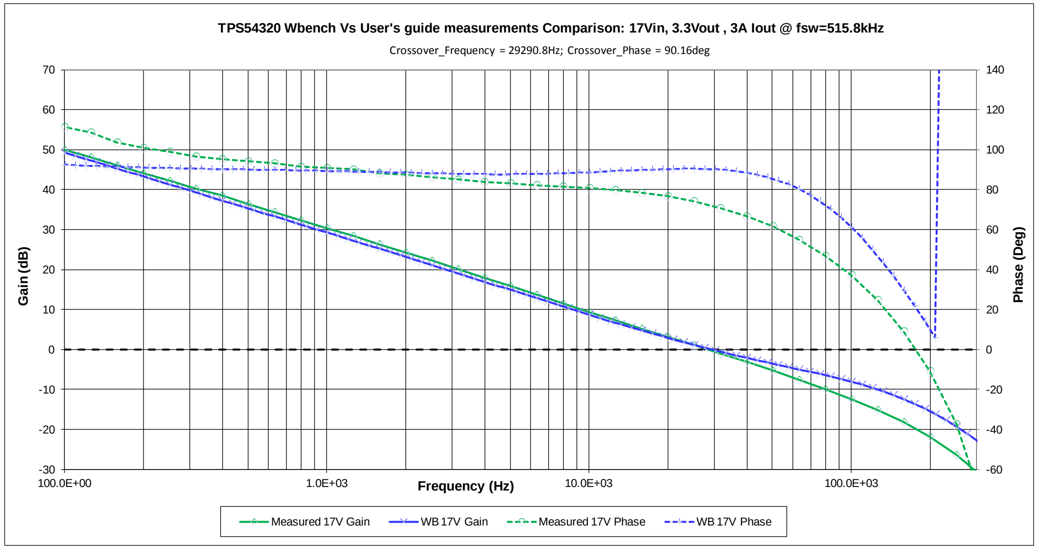
Overlay Simulations

- Red: LM22680 (Pulse Width Modulated)
- Blue: LM25576 (Emulated Current Mode) has faster transient response recovery time

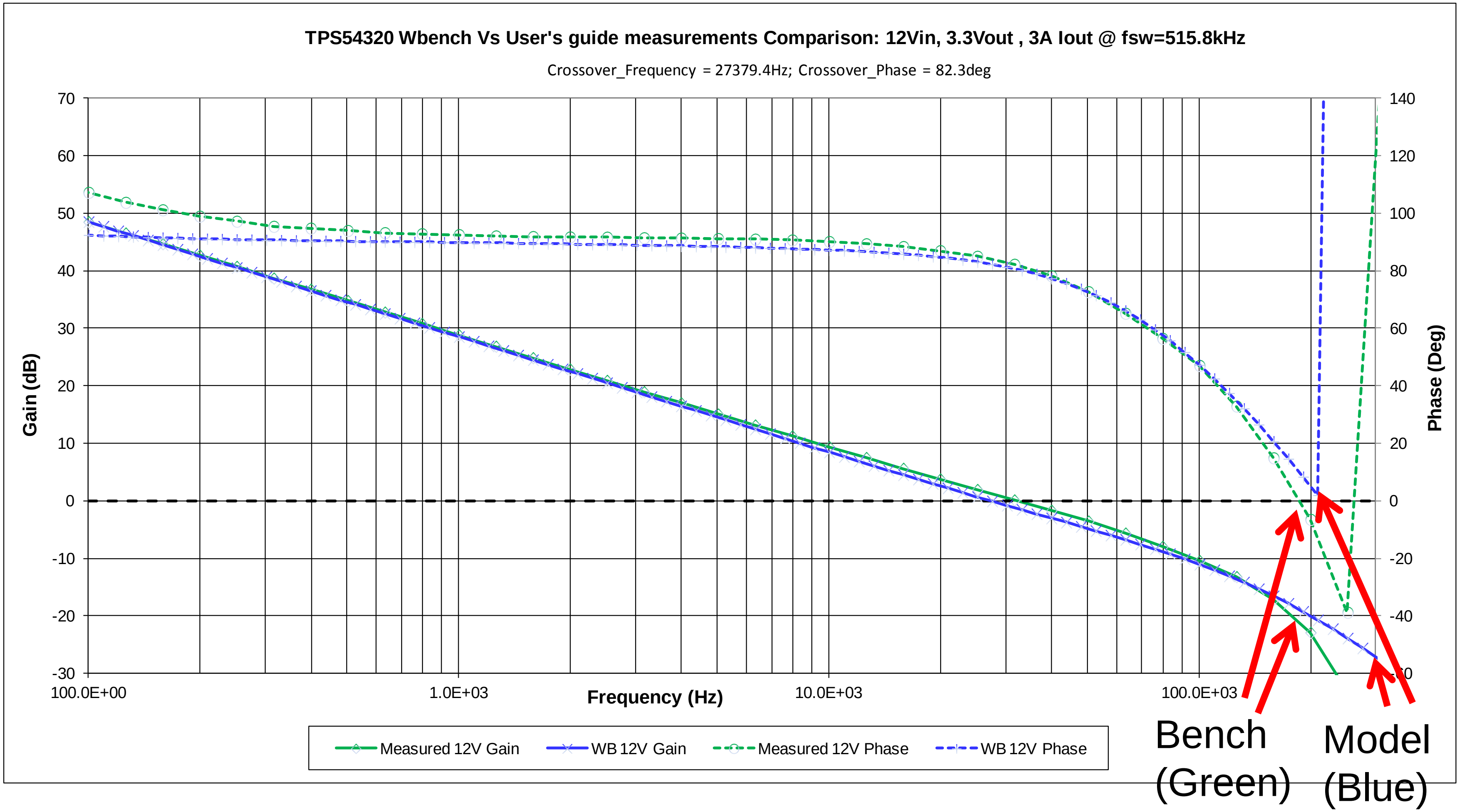


WEBENCH® Bode Plot Verification





WEBENCH® Bode Plot Verification



Hands-on Exercise:

Design Problem:	Goals:
Management has requested to check the load transient behavior of the following design: Vin: 14-22V Vout: 3.3V Iout: 1A Optimization 3 LM5010	Run a load transient simulation and note the overshoot and recovery time.

Why Do Thermal Simulation?

Identify Problems

- **Co-heating of parts not accounted for with ThetaJA**

Try Solutions

- **Change copper thickness, airflow, ambient temperature, voltage, current**

Visualize Results

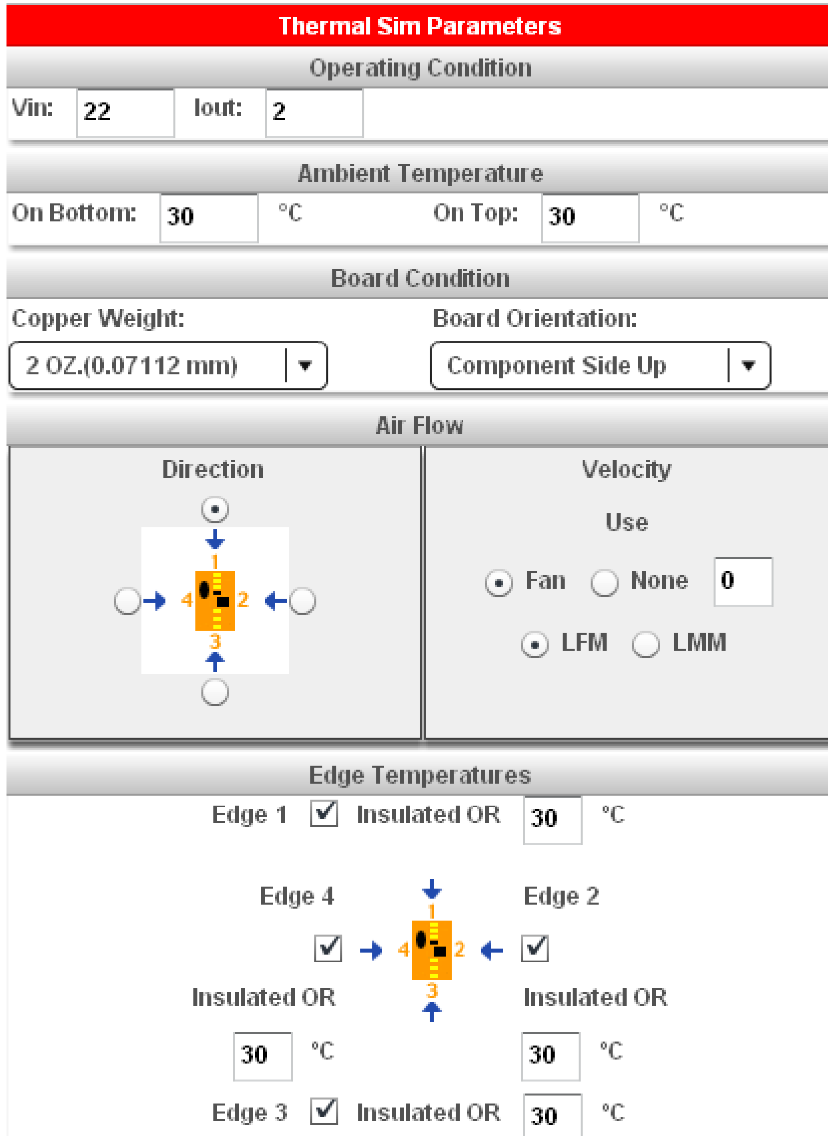
- **Color temperature plot across the board**
- **Adjustable scaling**

Why Do Thermal Simulation?

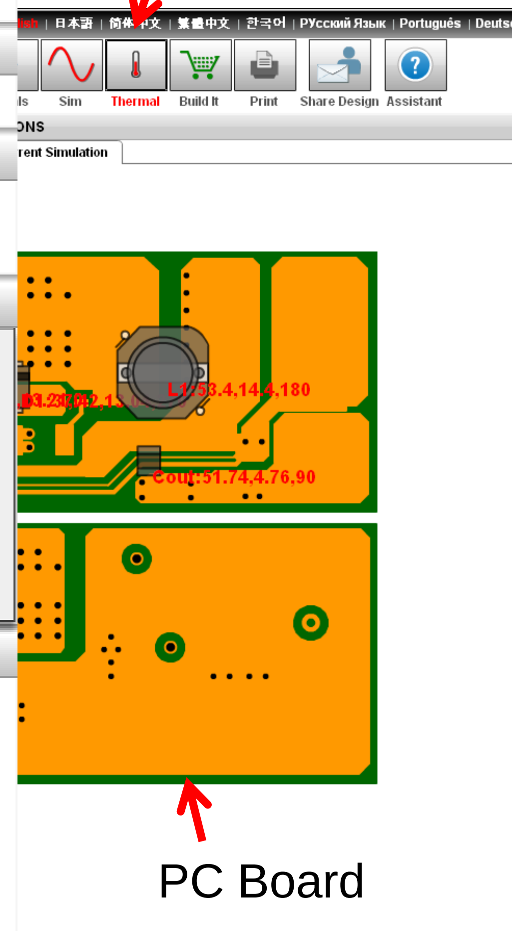
- Identify and solve thermal issues
  - Co-heating of adjacent parts not taken into account with thetaJA
- Different ways to solve thermal problems:
  - Heat sink
  - Fan
  - Copper area/thickness
- Thermal simulation factors
  - Model Types:
    - Physical geometry/materials modeled for regulator
    - Lumped cuboid models for passive components
    - Board modeled as a separate part, with traces modeled explicitly
  - Simulation accuracy
    - 3D conduction
    - Radiation
    - Convection

WebTHERM® – Board Layout

Inputs:
- Input voltage
- Current
- Top and bottom ambient temperature
- Copper thickness
- Airflow
- Board orientation



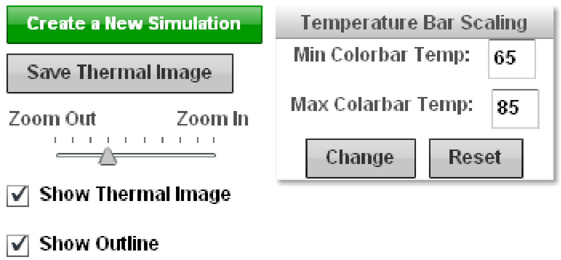
Thermal Sim Page



PC Board

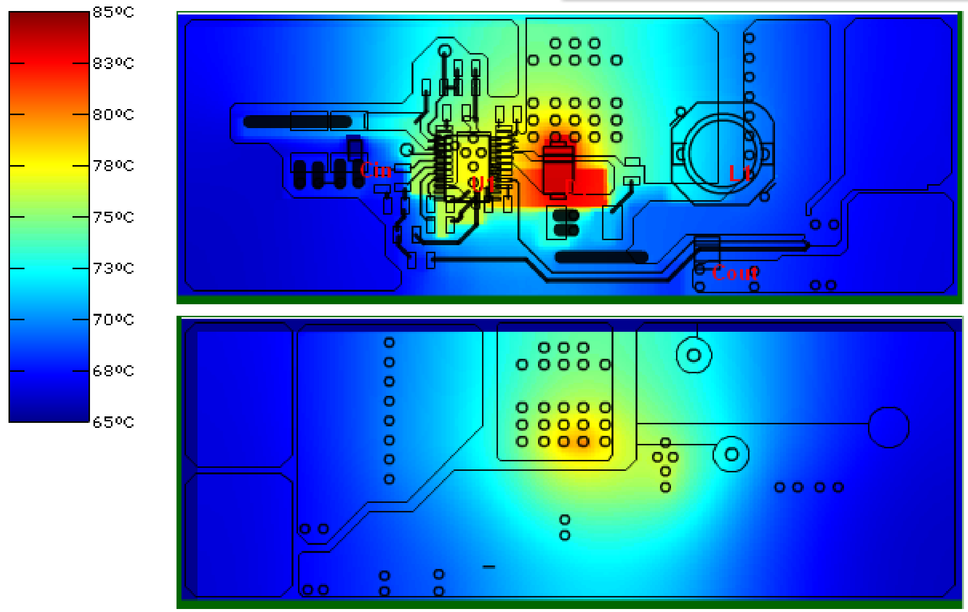
WebTHERM® Results

- View interactions between components
- Diode and IC both generate heat
- Effect of backside copper and vias



Operating Temperatures

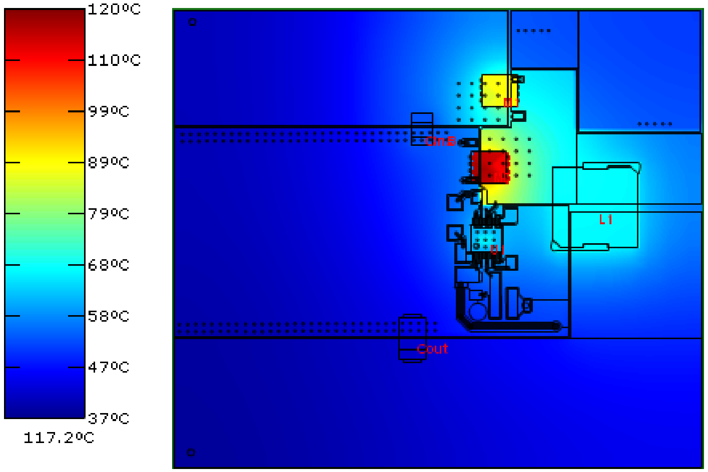
Layer	Max T	PDiss.	Manufacturer	Part Number
PCB - Top	83°C			
IC - Die	78°C	1.23 W	Texas Instruments	LM25576MH
L1	73°C	0.13 W	Coilcraft	MSS1048-103MLB
D1	84°C	0.83 W	Diodes Inc.	B340A-13-F
Cout	69°C	5.15e-5 W	TDK	C3225X5R0J107M
Cin	63°C	4.50e-3 W	TDK	C2012Y5V1H105Z
PCB - Bottom	80°C			

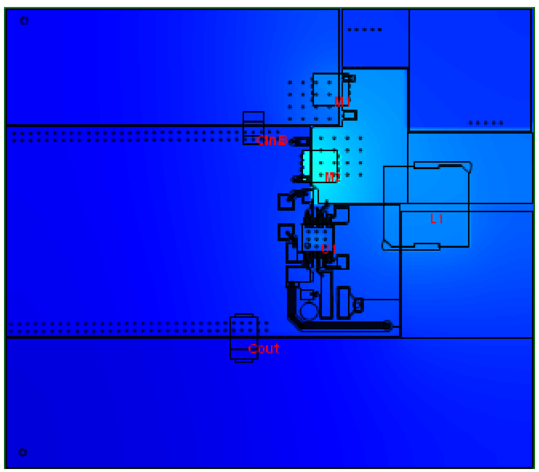


Top

Bottom

LM3150 Controller



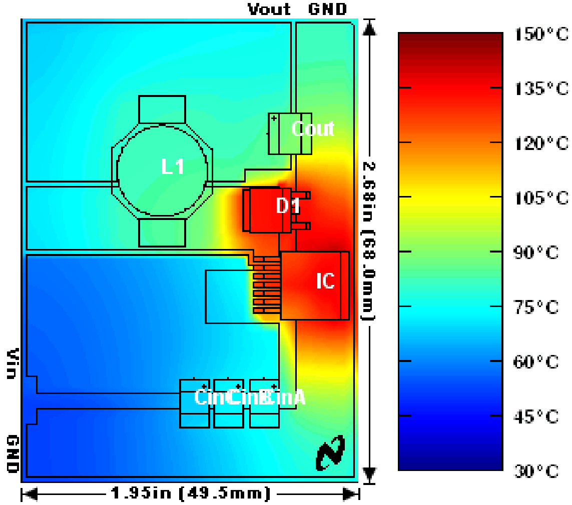


.5oz copper thickness
Low side FET is 117C

4oz copper thickness
Low side FET is 68C

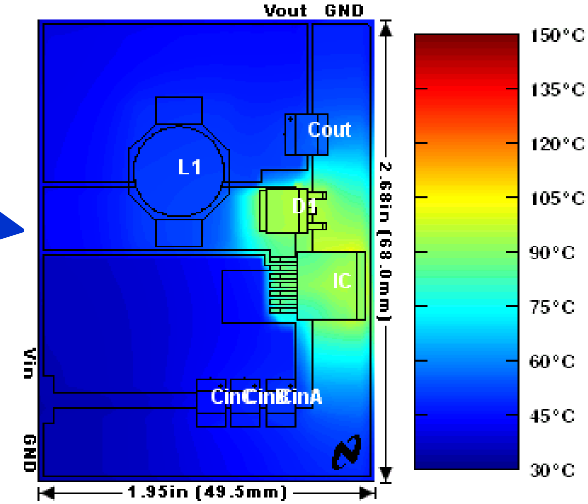
Vin: 14-22V
Vout: 3.3V
Iout: 6A

WebTHERM® Solutions



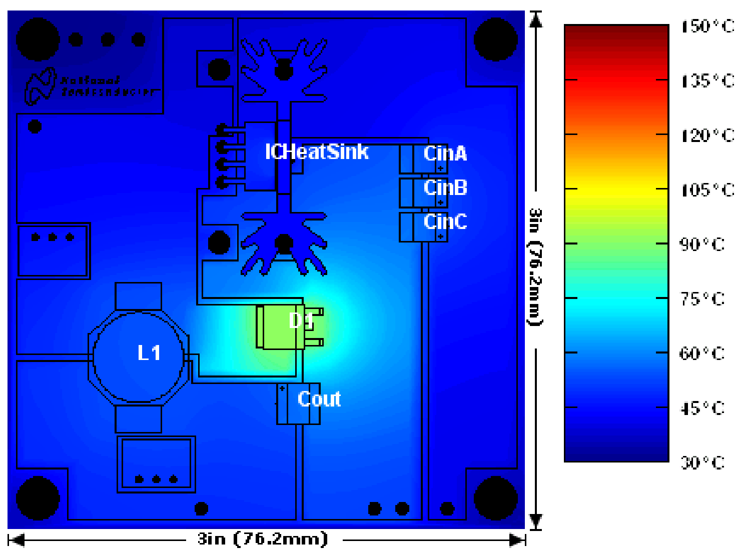
- No airflow
- Diode: 134C
- IC: 146C

Use a Fan



- 500 LFM airflow
- Diode: 95C
- IC: 106C

Or add a
Heat Sink



- No airflow
- Heat sink
- Diode: 91C
- IC: 52C

Design Specs:
Vin: 20-22V
Vout: 5V
Iout: 5A

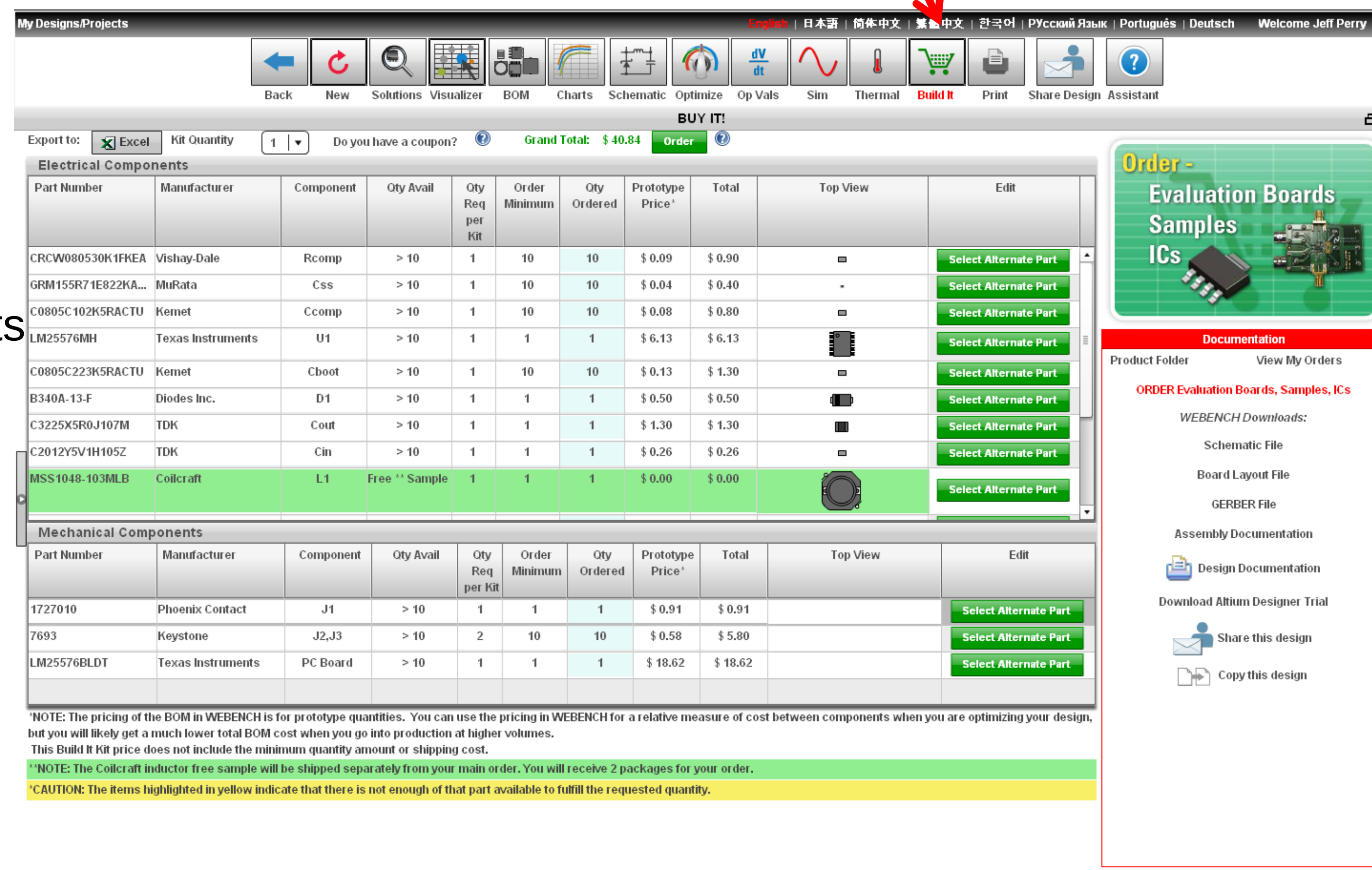
Hands-on Exercise:

Design Problem:	Goals:
Management has requested to create the following design: Vin: 14-22V Vout: 3.3V Iout: 9A Optimization 1 (small footprint) LM3150 Temperature must be below 70C	Run thermal simulations to determine what can be done to bring the design into spec.

Build It®

Build It Page

- •Order custom prototype kit:
- •Bare board and parts
- •Hourly pricing and inventory updates
- •Shipped overnight



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BUY IT!

Export to: Excel | Kit Quantity 1 | Do you have a coupon? | Grand Total: $ 40.84 | Order

Electrical Components

Part Number	Manufacturer	Component	Qty Avail	Qty Req per Kit	Order Minimum	Qty Ordered	Prototype Price¹	Total	Top View	Edit
CRCW080530K1FKEA	Vishay-Dale	Rcomp	> 10	1	10	10	$ 0.09	$ 0.90		Select Alternate Part
GRM155R71E822KA...	MuRata	Css	> 10	1	10	10	$ 0.04	$ 0.40		Select Alternate Part
C0805C102K5RACTU	Kemet	Ccomp	> 10	1	10	10	$ 0.08	$ 0.80		Select Alternate Part
LM25576MH	Texas Instruments	U1	> 10	1	1	1	$ 6.13	$ 6.13		Select Alternate Part
C0805C223K5RACTU	Kemet	Cboot	> 10	1	10	10	$ 0.13	$ 1.30		Select Alternate Part
B340A-13-F	Diodes Inc.	D1	> 10	1	1	1	$ 0.50	$ 0.50		Select Alternate Part
C3225X5R0J107M	TDK	Cout	> 10	1	1	1	$ 1.30	$ 1.30		Select Alternate Part
C2012Y5V1H105Z	TDK	Cin	> 10	1	1	1	$ 0.26	$ 0.26		Select Alternate Part
MSS1048-103MLB	Coilcraft	L1	Free ¹¹ Sample	1	1	1	$ 0.00	$ 0.00		Select Alternate Part

Mechanical Components

Part Number	Manufacturer	Component	Qty Avail	Qty Req per Kit	Order Minimum	Qty Ordered	Prototype Price¹	Total	Top View	Edit
1727010	Phoenix Contact	J1	> 10	1	1	1	$ 0.91	$ 0.91		Select Alternate Part
7693	Keystone	J2,J3	> 10	2	10	10	$ 0.58	$ 5.80		Select Alternate Part
LM25576BLDT	Texas Instruments	PC Board	> 10	1	1	1	$ 18.62	$ 18.62		Select Alternate Part

¹NOTE: The pricing of the BOM in WEBENCH is for prototype quantities. You can use the pricing in WEBENCH for a relative measure of cost between components when you are optimizing your design, but you will likely get a much lower total BOM cost when you go into production at higher volumes.
This Build It Kit price does not include the minimum quantity amount or shipping cost.

¹¹NOTE: The Coilcraft inductor free sample will be shipped separately from your main order. You will receive 2 packages for your order.

¹CAUTION: The items highlighted in yellow indicate that there is not enough of that part available to fulfill the requested quantity.

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Documentation

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WEBENCH Downloads:

Schematic File

Board Layout File

GERBER File

Assembly Documentation

Design Documentation

Download Altium Designer Trial

Share this design

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Complete Power Supply Design Reporting: Automatic Generation

Your Design From The Top: Inputs, Supplies, Schematics, BOMs

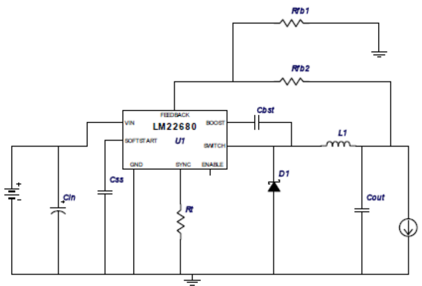
TEXAS INSTRUMENTS

WEBENCH® Design Report

Design : 171680/17764 LM22680MRX-ADJ
Design 17764 - LM22680MRX-ADJ

VinMin = 14.0V
VinMax = 22.0V
Vout = 3.3V
Iout = 2.0A

Device = LM22680MRX-ADJ
Topology = Buck
Created = 12/4/11 3:07:23 PM
BOM Cost = $3.05
Total Pd = 1.79 W
Footprint = 768.0 mm2
BOM Count = 13



Electrical BOM

#	Name	Manufacturer	Part Number	Quantity	Price	Properties	Footprint
1.	Cbst	Kemet	C0805C103K5RACTU Series= X7R	1	$0.01	Cap= 10.0 nF ESR= 1.739 Ohm VDC= 50.0 V IRMS= 411.0 mA	0805 13mm2
2.	Cin	Panasonic	EEE-FC1H470P Series= FC	2	$0.24	Cap= 47.0 µF ESR= 300.0 mOhm VDC= 50.0 V IRMS= 500.0 mA	SM_RADIAL_G 172mm2
3.	Cinx	TDK	C2012Y5V1H105Z Series= Y5V	2	$0.02	Cap= 1.0 µF ESR= 9.0 mOhm VDC= 50.0 V IRMS= 2.9 A	0805 13mm2
4.	Cout	TDK	C3225X5R0J107M Series= X5R	1	$0.39	Cap= 100.0 µF ESR= 2.0 mOhm VDC= 6.3 V IRMS= 3.5 A	1210 23mm2
5.	Css	AVX	08055C393KAT2A Series= X7R	1	$0.02	Cap= 39.0 nF ESR= 38.0 mOhm VDC= 50.0 V IRMS= 0.0 A	0805 13mm2
6.	D1	Diodes Inc.	B340A-13-F	1	$0.13	VF@Io= 500.0 mV VRRM= 40.0 V	SMA 37mm2

 1 national.com/webench

WEBENCH® Design Report LM22680MRX-ADJ : Design 17764 - LM22680MRX-ADJ December 4, 2011 3:16:32 P.M. pst

WEBENCH® Design

#	Name	Manufacturer	Part Number	Quantity	Price	Properties	Footprint
7.	L1	Bourns	SRR1206-100ML	1	$0.10	L= 10.0 µH DCR= 35.0 mOhm	SRR1206 216mm2
8.	Rfb1	Vishay-Dale	CRCW08051K00FKEA Series= CRCW..e3	1	$0.01	Res= 1,000 Ohm Power= 125.0 mW Tolerance= 1.0%	0805 13mm2
9.	Rfb2	Vishay-Dale	CRCW08051K58FKEA Series= CRCW..e3	1	$0.01	Res= 1.58 kOhm Power= 125.0 mW Tolerance= 1.0%	0805 13mm2
10.	Rt	Vishay-Dale	CRCW080561K9FKEA Series= CRCW..e3	1	$0.01	Res= 61.9 kOhm Power= 125.0 mW Tolerance= 1.0%	0805 13mm2
11.	U1	Texas Instruments	LM22680MRX-ADJ	1	$1.85	Switcher	PSOP-8 56mm2

Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	707.334 m A	Current	Input capacitor RMS ripple current
2.	Cout IRMS	159.841 m A	Current	Output capacitor RMS ripple current
3.	IC Ipk	2.277 A	Current	Peak switch current in IC
4.	Iin Avg	381.4 m A	Current	Average input current
5.	L Ipp	553.706 m A	Current	Peak-to-peak inductor ripple current
6.	M1 Irms	825.289 m A	Current	Q Iavg
7.	BOM Count	13.0	General	Total Design BOM count
8.	FootPrint	768.0 mm2	General	Total Foot Print Area of BOM components
9.	Frequency	575.061 k Hz	General	Switching frequency
10.	IC Tolerance	19.0 m V	General	IC Feedback Tolerance
11.	M Vds Act	183.227 m V	General	
12.	Mode	CCM	General	Conduction Mode
13.	Pout	6.6 W	General	Total output power
14.	Total BOM	$3.05	General	Total BOM Cost
15.	D1 Tj	112.972 degC	Op_Point	D1 junction temperature
16.	Cross Freq	54.069 k Hz	Op_point	Bode plot crossover frequency
17.	Duty Cycle	17.028 %	Op_point	Duty cycle
18.	Efficiency	78.657 %	Op_point	Steady state efficiency
19.	IC Tj	73.924 degC	Op_point	IC junction temperature
20.	ICThetaJA	60.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
21.	IOUT_OP	2.0 A	Op_point	Iout operating point
22.	Phase Marg	46.455 deg	Op_point	Bode Plot Phase Margin
23.	VIN_OP	22.0 V	Op_point	Vin operating point
24.	Vout p-p	2.413 m V	Op_point	Peak-to-peak output ripple voltage
25.	Cin Pd	75.048 m W	Power	Input capacitor power dissipation
26.	Cout Pd	51.098 µ W	Power	Output capacitor power dissipation
27.	Diode Pd	829.724 m W	Power	Diode power dissipation
28.	IC Pd	732.069 m W	Power	IC power dissipation
29.	L Pd	154.0 m W	Power	Inductor power dissipation
30.	Total Pd	1.791 W	Power	Total Power Dissipation
31.	Vout OP	3.3 V	Unknown	Operational Output Voltage

Design Inputs

#	Name	Value	Description
1.	Iout	2.0 A	Maximum Output Current
2.	Iout1	2.0 Amps	Output Current #1
3.	SoftStart	1.0 ms	Soft Start Time (ms)
4.	VinMax	22.0 V	Maximum input voltage
5.	VinMin	14.0 V	Minimum input voltage
6.	Vout	3.3 V	Output Voltage
7.	Vout1	3.3 Volt	Output Voltage #1
8.	base_pn	LM22680	National Based Product Number
9.	Ta	30.0 degC	Ambient temperature
10.	UserFsw	600.0 kHz	Customer Selected Frequency

Design Assistance

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WEBENCH® Design Report LM22680MRX-ADJ : Design 17764 - LM22680MRX-ADJ December 4, 2011 3:16:32 P.M. pst

TEXAS INSTRUMENTS

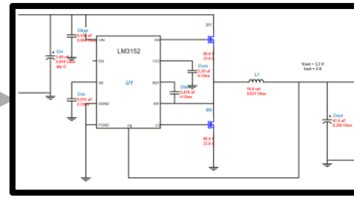
WEBENCH® Schematic Export

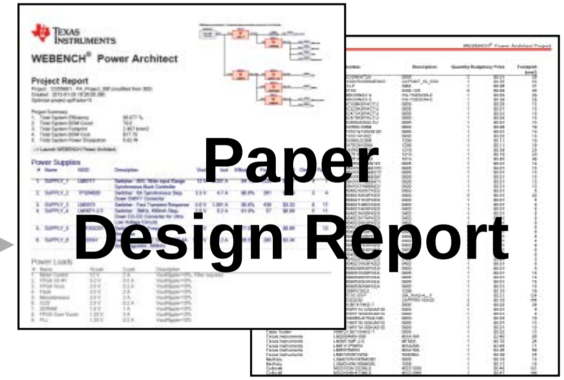
- TI's WEBENCH power and LED lighting design tools are the industry's leading online tools to create and optimize analog designs.
- Before: Designers create a report in PDF summarizing the WEBENCH design and manually input the schematic into the CAD tool.
- Today: With WEBENCH Schematic Export, designers can export the schematic directly to five popular CAD formats.
- Advantages:
  - Saves time
  - Reduces errors
  - Allows use of optimized WEBENCH schematics

Export WEBENCH® designs directly to CAD environment

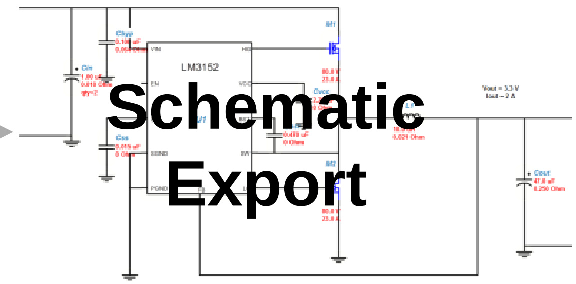
TEXAS INSTRUMENTS WEBENCH® Design Center

Design Creation





Paper Design Report



Schematic Export

Value inputs

- System design IP
- Component calculation
- Vendor selection
- Performance optimization
- Size optimization
- Relative pricing
- Speed/accuracy

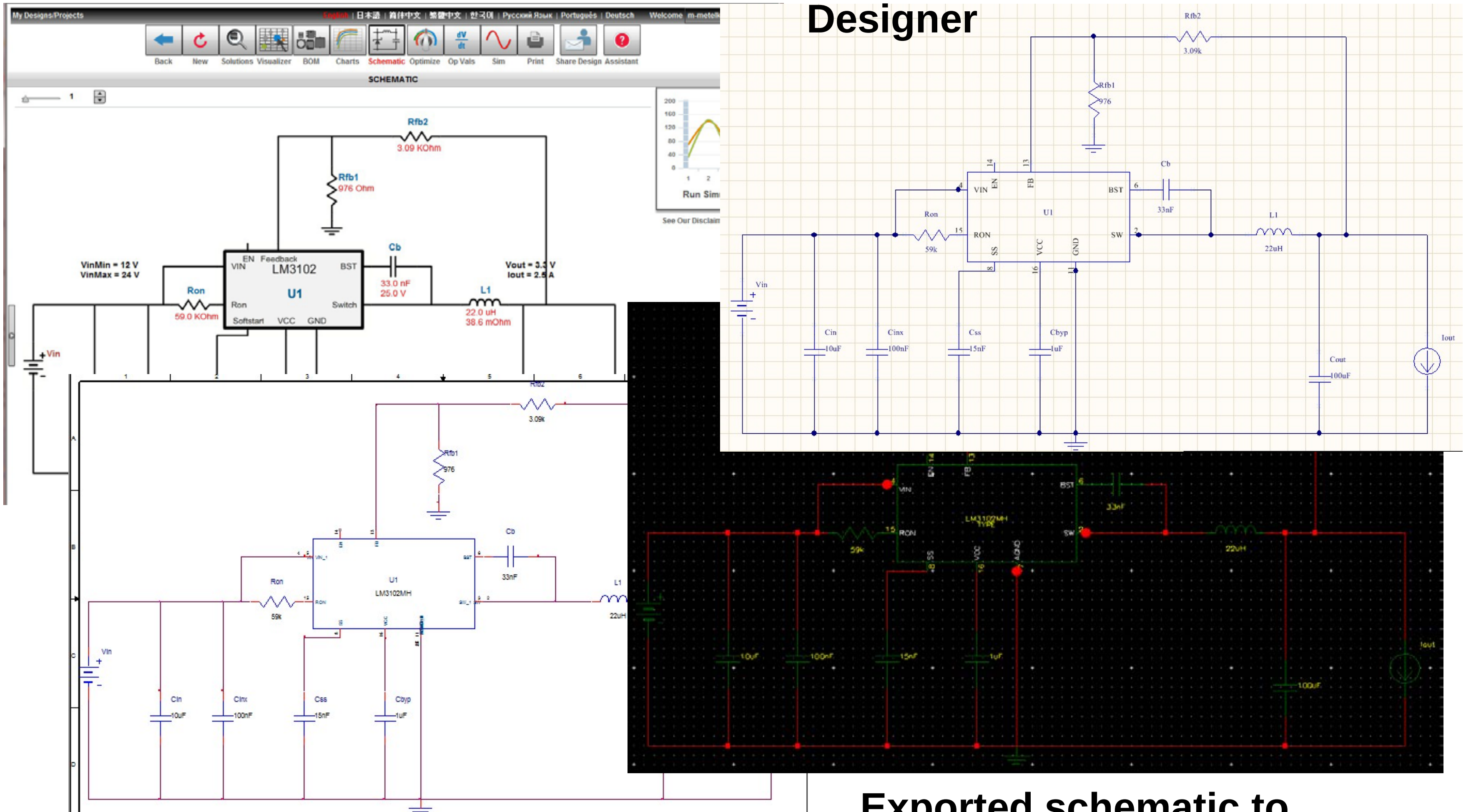
Export directly into CAD formats

Altium	Altium Designer
cadence®	OrCAD Capture CIS
Mentor Graphics®	DxDesigner
DESIGNSPARK	DesignSpark
Altium	P-CAD

WEBENCH® Export Directly to CAD Tool

WEBENCH schematic

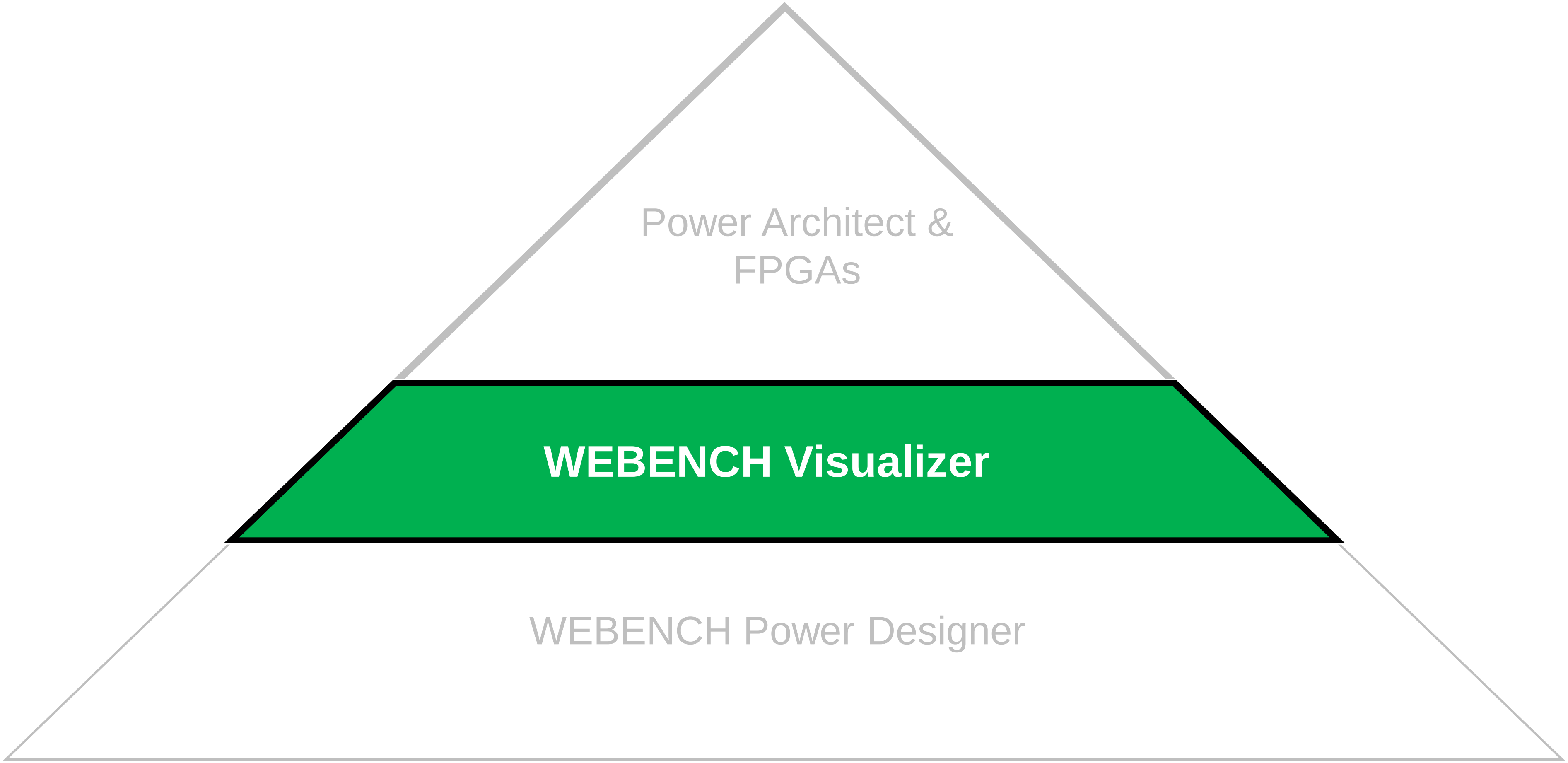
Exported schematic to Altium Designer



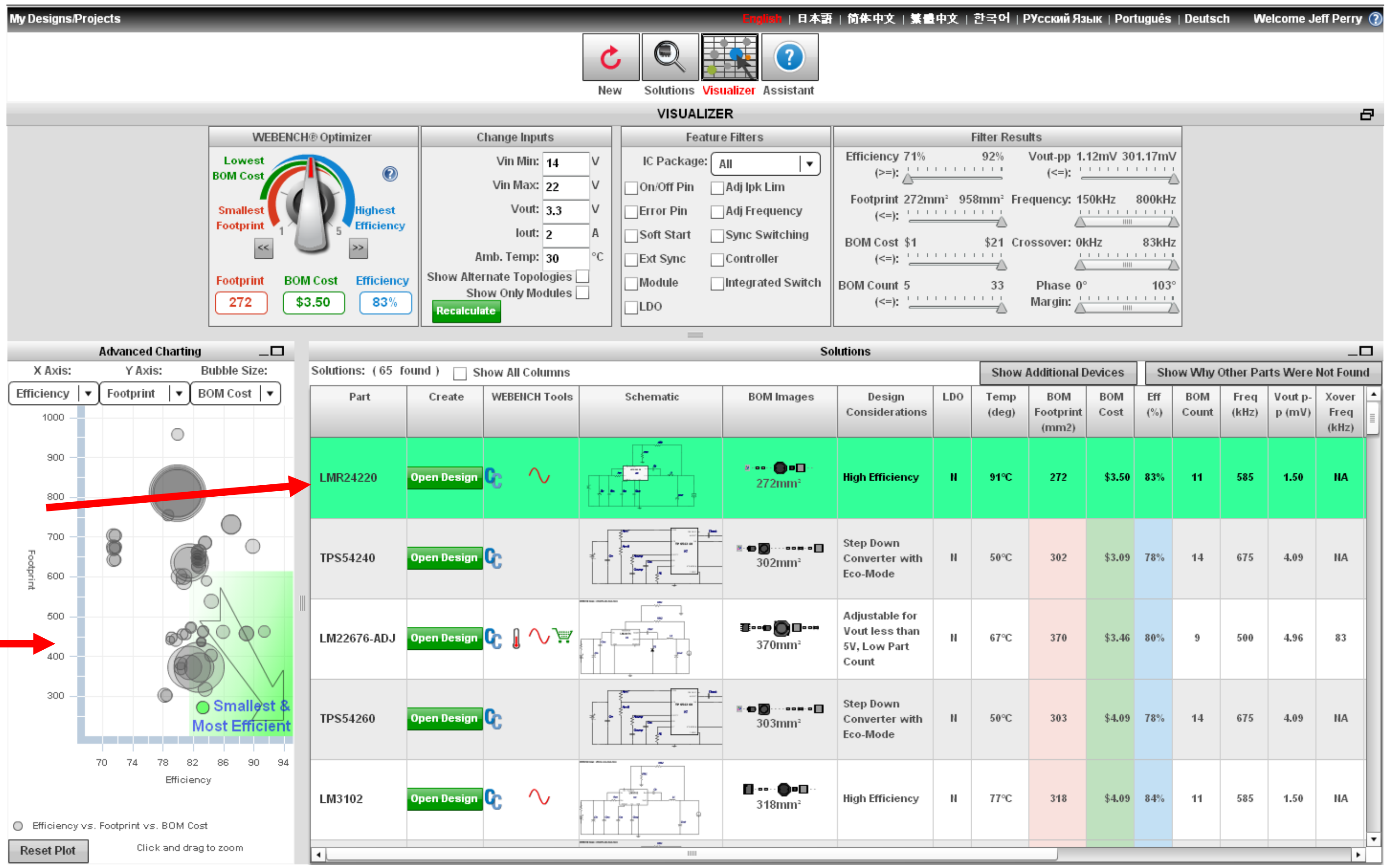
Exported schematic to Cadence OrCAD

Exported schematic to Mentor Graphics DxDesigner

The WEBENCH® Tool Suite



WEBENCH® Visualizer-
Calculates 65 Designs in 10 Seconds



Part	Create	WEBENCH Tools	Schematic	BOM Images	Design Considerations	LDO	Temp (deg)	BOM Footprint (mm2)	BOM Cost	Eff (%)	BOM Count	Freq (kHz)	Vout p-p (mV)	Xover Freq (kHz)
LMR24220	Open Design			272mm²	High Efficiency	N	91°C	272	$3.50	83%	11	585	1.50	NA
TPS54240	Open Design			302mm²	Step Down Converter with Eco-Mode	N	50°C	302	$3.09	78%	14	675	4.09	NA
LM22676-ADJ	Open Design			370mm²	Adjustable for Vout less than 5V, Low Part Count	N	67°C	370	$3.46	80%	9	500	4.96	83
TPS54260	Open Design			303mm²	Step Down Converter with Eco-Mode	N	50°C	303	$4.09	78%	14	675	4.09	NA
LM3102	Open Design			318mm²	High Efficiency	N	77°C	318	$4.09	84%	11	585	1.50	NA

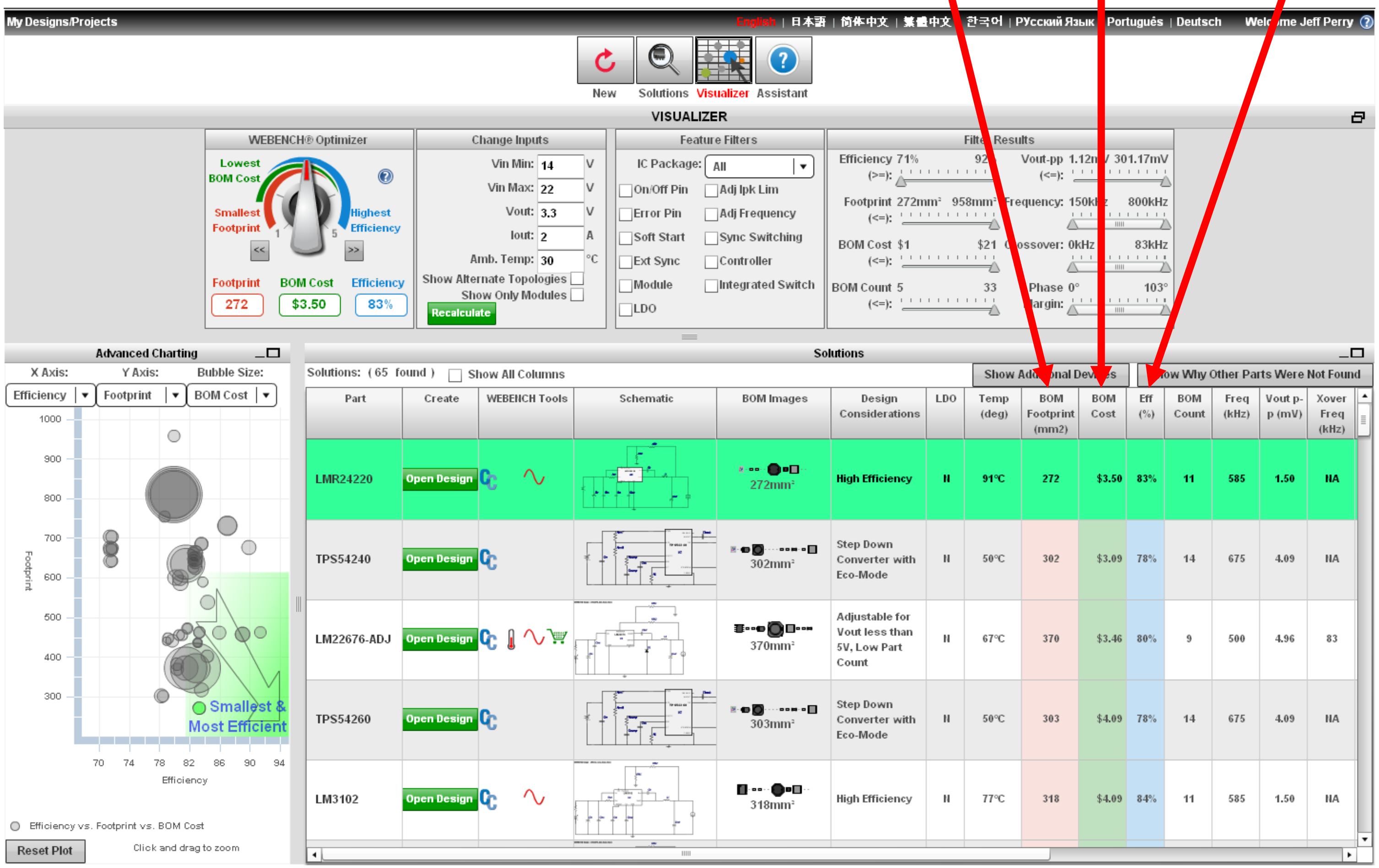
Recommended Solutions

Charts

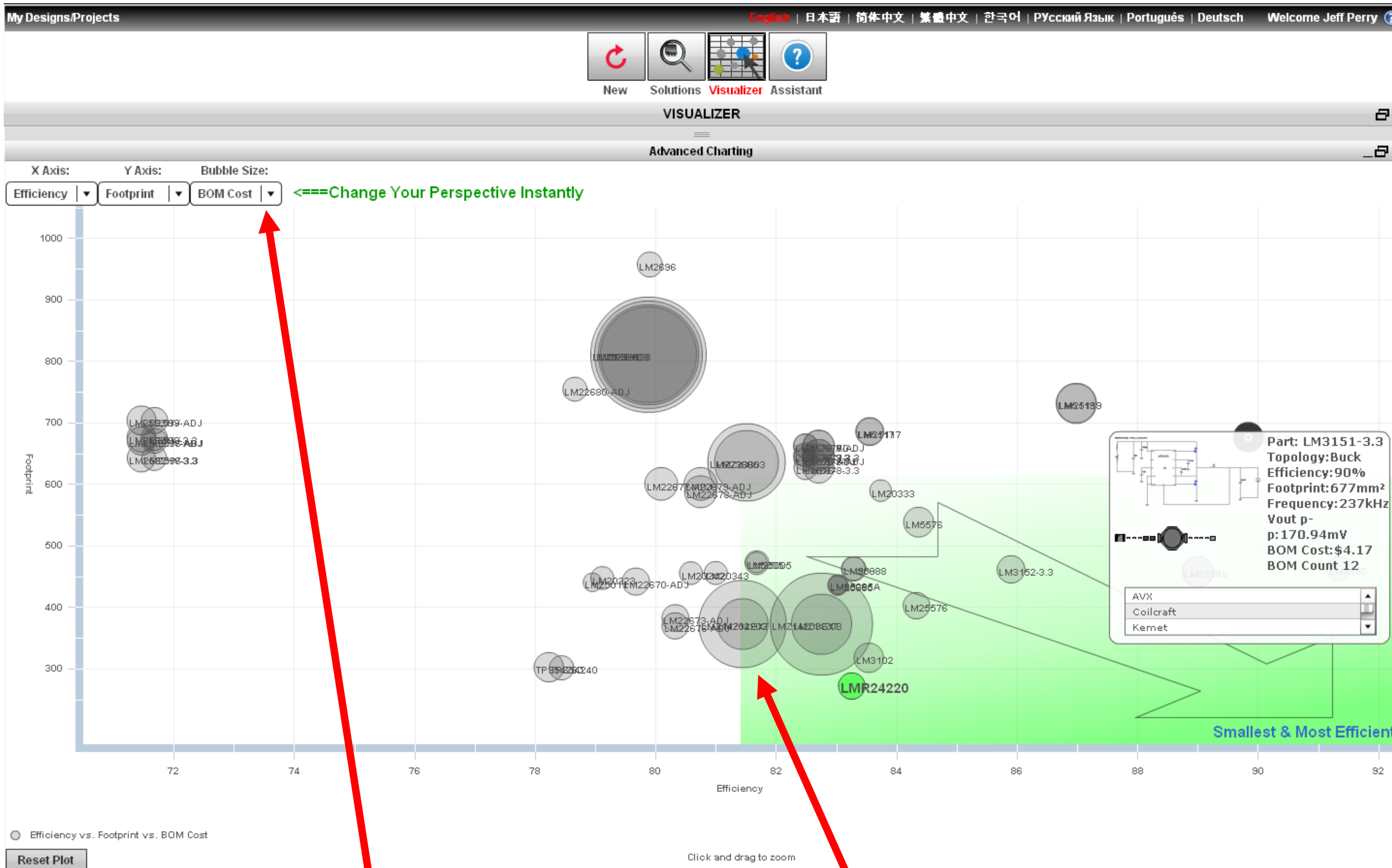
Texas Instruments

Calculated BOM Footprint, BOM Cost and Efficiency

Footprint vs Cost vs Efficiency



Graphical Plot Gives at a Glance Trade-offs



Click on square to resize the plot to full screen size

Hover to see details

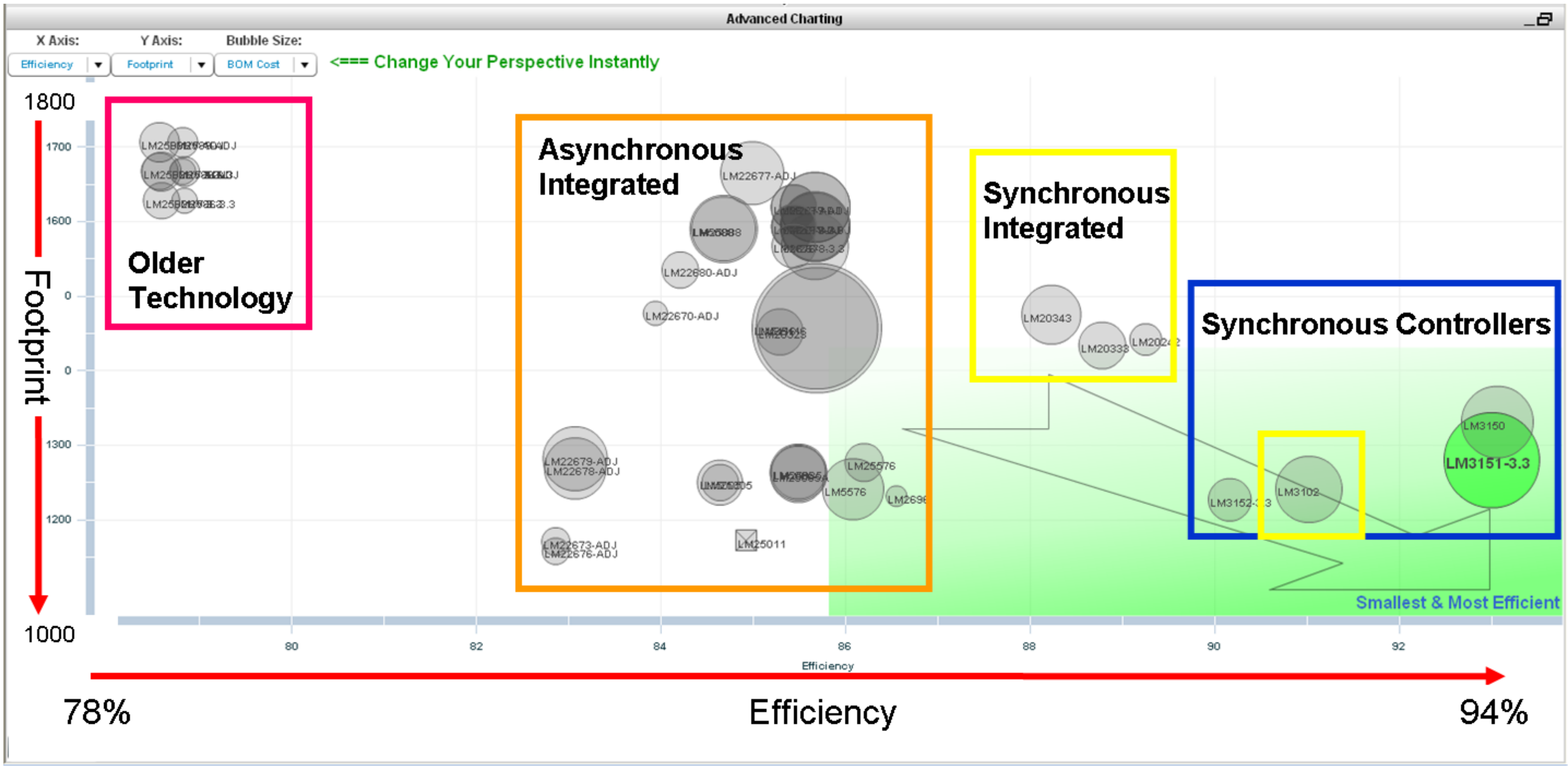
Click and drag to zoom

Change plot parameters

Bubble Size = BOM Price

Texas Instruments

Why Are the Solutions Different?



Texas Instruments

Give The Engineers What They Want: Best Efficiency, Footprint and BOM Cost

Results from example:

Filter: Integrated Switch
Vin = 14V to 22V
Vout = 3.3V
Iout = 2.0A

- Default Setting: LM25005, 83%, 416mm², $2.13

- Smallest Footprint: LMR24220, 78%, 218mm², $2.47

- Highest Efficiency: LM26003, 91%, 1357mm², $4.84

- Hint:

  At each setting sort first for the most relevant parameter, then look for best compromize on the others

Hands-on Exercise:

Design Problem:	Goals:
Take the previous design requirements and see if you can find a better solution than the LM22680: Vin: 14-22V Vout: 3.3V Iout: 2A	What is the system with the: Smallest footprint Highest efficiency Lowest cost Note the device used and the value of all 3 factors for each design

WEBENCH® Power Designer

End-to-end design solutions
Online selection, simulation and prototyping
Dynamic design optimization based on size, cost and efficiency

WEBENCH Visualizer
- View dozens of designs at a time to get the best solution for a single power supply
- Each design optimized for efficiency, cost and size

WEBENCH Power Architect
- System level designs for complex multiple load applications
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Thank You!

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- 2010 EDN “Innovation of the Year”
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